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THE LOW-PRESSURE STEAM TURBINE*

HOW IT WORKS; ITS CONSTRUCTION

BY L. L. WILLARD

INSTALLATION of specially constructed steam turbines for the use of steam at a pressure near that of the atmosphere has reached a stage where there are no questions as to their future success. Like all types of prime movers, however, they have a certain field of usefulness, but great care should be taken that they are not installed outside of this field, in order to secure satisfactory results.

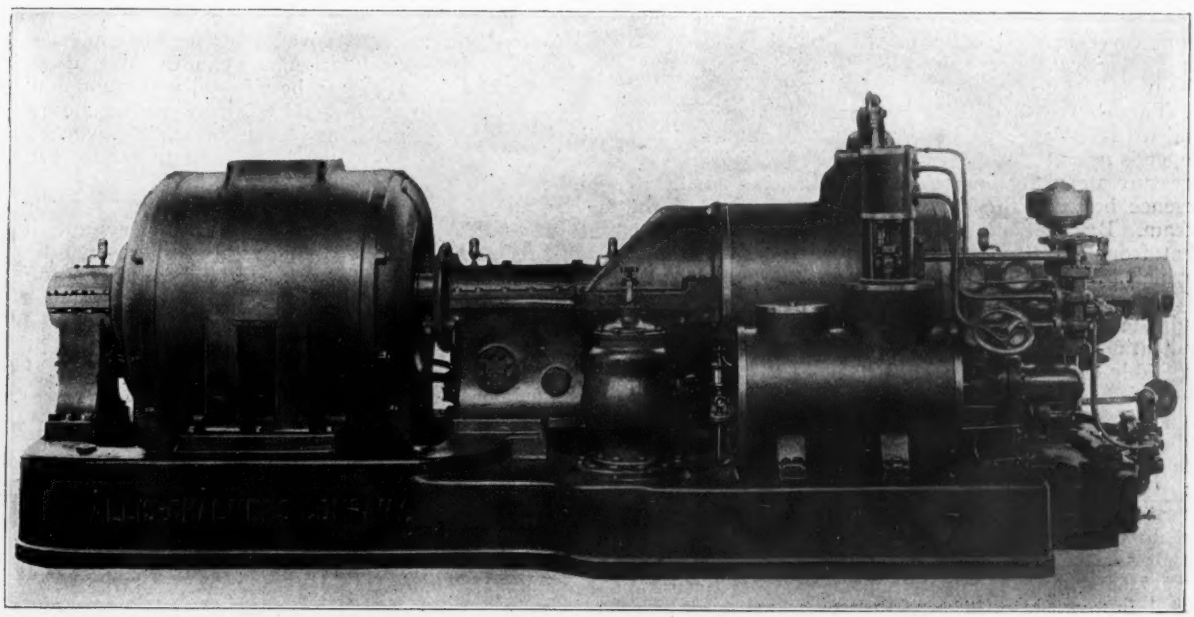

FIG. I. THE LATEST TYPE OF ALLIS-CHALMERS LOW-PRESSURE TURBINE

The general impression held by many has been that wherever an available supply of exhaust steam existed, there was the place for the low-pressure steam turbine.

The low-pressure steam turbine, like the gas engine, and in fact like any type of prime mover, has passed through the various stages of development, until its proper field is now definitely determined. It is the object of this paper to endeavor to show under what conditions and why the low-pressure steam turbine is a success.

Reason for Efficiency

In any form of heat engine, the greater the range of temperature through which the engine or combination of turbine and engine works, the greater the efficiency. It is therefore advisable in most plants to use as high a steam pressure and vacuum as practicable.

By referring to Fig. 2 there will be seen 2 curves. The one marked A is for engines exhausting at atmos-

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pheric pressure, and can be applied to the usual non-condensing engine. It will be noted that if steam at 150 lb. gage pressure is used, the efficiency of a perfect heat engine can be found by following horizontally from the 150-lb. division on the left of the diagram to the point of intersection with the curve, and then vertically downward to the line of figures at the bottom, showing in this case about 18 per cent efficiency.

If it is desired to increase this efficiency, we can do either or both of 2 things: increase the steam pressure or make use of a vacuum. If the steam pressure is increased to 175 lb. gage, the efficiency will be found to be 19 per cent, which is an increase of 6 per cent.

If a vacuum is used, it will only be necessary to carry it to approximately 4.3 in. to give the same

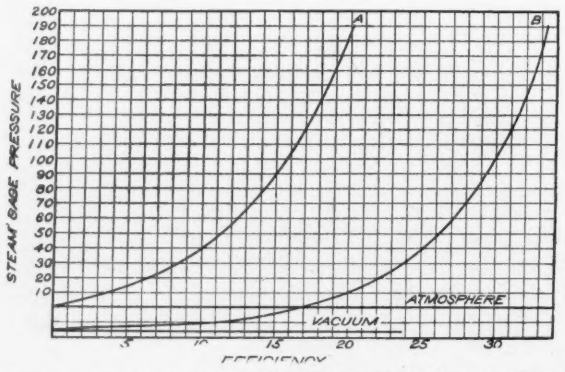


FIG. 2. EFFICIENCY OF NON-CONDENSING AND CONDENSING ENGINES

efficiency as a 25-lb. increase in the steam pressure, i. e., from 150 to 175 lb. If instead of increasing the steam pressure, we use a vacuum of 28 in. the efficiency from curve marked B becomes for 150-lb. gage pressure about 32.2 per cent for 175-lb. gage pressure, about 33 per cent.

This shows, then, the great value of the condenser, and what a large proportion of the total efficiency depends upon the vacuum. It also shows why the low-pressure steam turbine is efficient on such a small difference between the initial and final pressure of the steam. By referring again to curve B it will be seen that from the atmospheric pressure to 1 lb. absolute (which is practically 28 in. vacuum) the efficiency is 16.5 per cent, which is about equal to the efficiency indicated from steam at 175-lb. gage to the atmosphere, indicating practically the same amount of energy available each side of the atmosphere.

It is well known that for a steam engine, in the neighborhood of 26 in. of vacuum is generally used, where sufficient condensing water is available. When it is desired to utilize a vacuum of 28 in. the low-pressure cylinder must be increased to take care of the greater expansive range, which not only gets us into mechanical difficulties, but provides such a large radiating surface that the additional condensation offsets to a greater extent the gain expected. With a turbine we do not run into these difficulties, as will be shown.

Possible Expansion and Cylinder Ratios.

One pound of dry saturated steam expanding in an efficient power generating machine from an initial pressure of 175 lb. above atmosphere (or 190 lb. absolute) to a terminal pressure of 1 lb. absolute (about equivalent to a vacuum of 28 in. referred to a 30-in. barometer) would increase in volume approximately 119 times.

To expand the steam through this full range in a compound engine having a cylinder ratio of 6.5 to 1, with 3 per cent clearance, in the high-pressure cylinder, would necessitate a cutoff at 2.5 per cent of the stroke in the high-pressure cylinder. At this short cutoff the cylinder condensation and friction losses would be so heavy a percentage of the useful effort that the efficiency of the machine would be extremely low.

To obtain a later cutoff in the high-pressure cylinder the cylinder ratio would have to be increased; for instance with a cutoff at 25 per cent of the high-pressure cylinder volume, a cylinder ratio of about 30 to 1 would be required for the full expansion. This would mean a low-pressure cylinder of abnormal proportions,

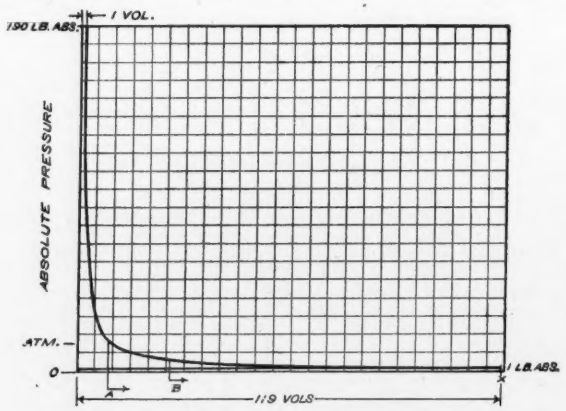


FIG. 3. STEAM EXPANSION CURVE

and the excessive losses would still exist, being merely transferred from the high-pressure to the low-pressure side of the engine.

Actual practice has proved that, for the range of pressure under consideration, a cylinder ratio of 6.5 or 7 to 1 is as great as can be allowed in a compound engine in order to attain good efficiency within the ordinary range of loads, and even in triple-expansion engines it has not been found advisable to use a much higher ratio.

In an engine having a cylinder ratio of 6.5 to 1, the steam would expand to 26 times its initial volume, if cutoff is at 25 per cent of the high-pressure cylinder volume; or to only 8.7 times its initial volume, if cutoff is at 75 per cent of the high-pressure cylinder volume. Figure 2 shows the complete expansion of 1 volume of dry saturated steam from an initial pressure of 190 lb. absolute, to a terminal pressure of 1 lb. absolute; the volumetric expansion from I to X being 119. In a compound engine having a cylinder ratio of 6.5 to 1, cutting off at 25 per cent of the high-pressure cylinder volume, the release would be at B; or, cutting off at 75 per cent of the high-pressure cylinder volume, the release would be at A. The remaining energy from B to X or from A to X, respectively, would be lost in the exhaust. It is to utilize this remaining energy that low-pressure steam turbines are used.

Construction

In its construction the low-pressure steam turbine differs from the ordinary high-pressure condensing steam turbine in having fewer stages or rows of blades or buckets. In proportion to its power, these blades or buckets are of large dimensions; the steam inlet is also of noticeably large area. The problems to be dealt with in designing such a turbine are simplified in one respect, viz., there are no great temperature differences to be reckoned with.

On the other hand, the volume of steam to be controlled is so great, and its available range in pressure so small, that such details as inlet and governing gear are difficult to accommodate and make efficient. As regards efficiency, it is generally agreed that the low-pressure turbine has a higher thermodynamic efficiency than its high-pressure sister.

Availability

The first thought about low-pressure turbines seems almost always to come from an existing plant in need of more power, and in many instances where the space for new units is very limited. Up to the present time this condition is met with more frequently than any other; also the field for the low-pressure turbine seems larger in this direction than any others. This type of station then is what we might consider the first case.

If this particular station is equipped with noncondensing engines, and has water available for condensing purposes, we have very favorable conditions for high efficiency with a minimum increase of investment for an increase of power by a large percentage.

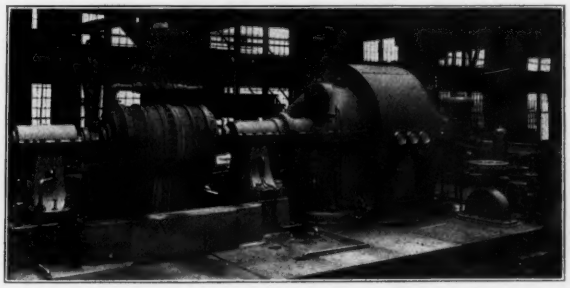


FIG. 4. WESTINGHOUSE LOW-PRESSURE STEAM TURBINE UNDER TEST

The second case might be considered as where the engines in the existing plant are being operated condensing, and where additional power is required. It will readily be seen here that a more careful investigation will have to be made on account of the fact that the engines are designed with a larger cylinder ratio to operate on a greater range in pressures, so that in some instances it has been found advisable to replace the low-pressure cylinders with others that were smaller, to secure the best results. A turbine operating in connection with an existing engine with a large cylinder ratio might be compared to a triple expansion engine with an intermediate cylinder too large. The overall economy will not equal that of the first case.

The third case often brought to the engineer's attention, especially in the last year or 2, is that of a completely new installation comprising noncondensing engines and low-pressure turbines. This is the most difficult case which we have considered, and requires a very careful investigation.

Steam Regulation

With these various conditions before the builder, it has been necessary to design a turbine such as would be absolutely reliable, and which would not only carry its load under conditions on exhaust steam, but also in many cases automatically allow sufficient live steam to be admitted to the turbine to take care of an insufficient supply of exhaust from the engines.

When the load on the engines is comparatively steady, the back pressure can be kept practically constant and the exhaust from the engines is admitted to the turbine, being controlled by the governor.

When the load on the engines is intermittent, as in a rolling mill and hoisting engine work, the exhaust is carried into a large storage vessel, and the pressure kept constant by means of live steam admitted through an automatic reducing valve, which makes up for any deficiency of steam from the engine, should it occur. This vessel can be provided with a relief valve, so that if the load on the turbine falls off by a large amount, the pressure in the tank does not rise beyond a certain predetermined limit, thus preventing undue back pressure on the engines.

When the engines and the turbine drive electric generators of the same characteristics, the turbine is "floated in" on the line, the engines and turbine being tied together electrically, and the turbine being without a governor. With this method, the back pressure on the engines, and, consequently the inlet pressure to the turbine, rises and falls with the load, and the 2 units automatically divide the load between them.

Load Regulation

Speed regulation is effected by the governors of the engines. If the electric current is alternating, its frequency assists in holding the engines and turbine to speed; but the actual control is the division of the load to suit the capacity of each unit. Assume that the turbine has a tendency to run ahead of the engine a slight increase in speed causes it to take a greater share of the load, reducing the load on the engines; these then speed up, cut off shorter, and, by so doing, reduce their terminal pressure, and therefore the initial pressure at the turbine, causing the turbine to slow down slightly and thus throw back part of the load upon the engines. This exchange takes place with such slight variations that no "see-sawing" of load or speed are perceptible.

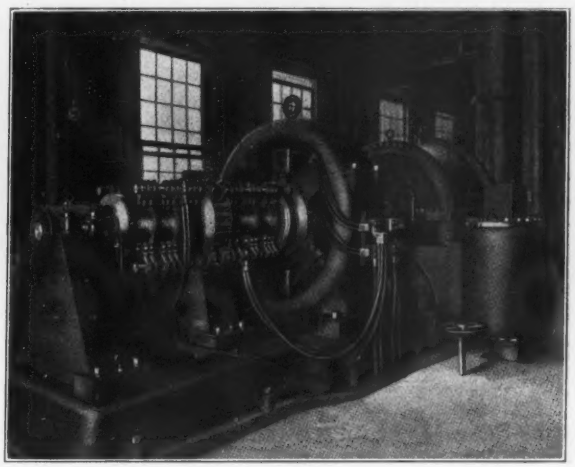


FIG. 5. RATEAU-SMOOT LOW-PRESSURE TURBINE DRIVING D. C. GENERATOR

The foregoing applies particularly to straight low-pressure turbines, which are not intended to operate with live steam as independent units for more than very brief periods. Such turbines are generally provided with live steam connections, either opened and closed by hand, or automatically controlled by a governor; but when operating with live steam their efficiency is very low.

It is occasionally necessary to operate a turbine under such conditions that there is, for considerable periods insufficient exhaust steam from engines to

carry the turbine load, and this must be supplemented in whole or part by live steam directly from boilers. To meet this special requirement the so-called Mixed Pressure Turbine has been developed.

This consists essentially of a low-pressure steam turbine ahead of whose first low-pressure stage there has been added a high-pressure stage which runs idle (absorbing power by churning) when low-pressure steam alone is used, and not over efficiently when live steam is used in whole or part. The objection to this type of turbine is that it is not first-class either as a high-pressure or as a low-pressure machine, so that the conditions which justify it, where a low-pressure turbine is at all warranted, are extremely rare.

TIGHT VS. LOOSE BELTS

THE GAIN FROM RUNNING AT LOW TENSION

By Harry H. Yates

NOTWITHSTANDING the familiar heading, I wish at the beginning to state that this article is not an advertisement of any particular brand of belt dressing, the cases described being the result of attention to small matters and keeping belts in soft, pliable condition, the credit for which cannot be claimed by the manufacturer of any one dressing as several, ranging from castor oil and other liquids to paste and bar form, have been used, in fact more experimenting has been done than desired by the writer.

The cases to be described have been selected from about 125 leather belts of various styles and sizes, ranging from 1-in. to 8-in. single, 2.5-in. to 26-in. double and 18-in. 3-ply, practically all of them being run "easy" and many very loose.

The writer formed a favorable opinion of loose belts

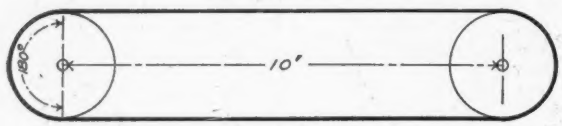


FIG. 1

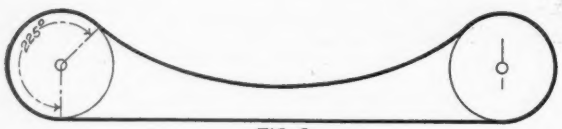


FIG. 2

FIG. 1. TIGHT BELT
FIG. 2. LOOSE BELT

early in his engineering experience and later experiments and results have proved the correctness of that opinion.

First the theoretical reason for running belts loose will be given and later a few specific cases will be illustrated.

Increasing the Contact.

Suppose that we take for an example a 6-in. single belt running over 2 pulleys, say 30 in. in diameter, with 10 ft. center to center (Fig. 1).

The circumference of a 30-in. pulley equals $30 \times 3.1416 = 94.248$ in. If the belt is tight 0.5 or 180 deg. of the pulley circumference will be in contact with the belt or 47.124 in. 47.124×6 (the width of the belt) $= 282.744$ sq. in. of leather in contact with the pulley.

Now suppose that the belt is made loose enough to wrap 225 deg. or 0.625, the circumference (Fig. 2) of the pulley. $94.248 \times 0.625 = 58.905$ in., which, multiplied by 6 (the width of the belt) equals 353.43 sq. in. in contact instead of 282.744, and this is only a small belt.

Decreasing Friction

While we have been increasing the area of the belt in contact with the pulley, we have at the same time secured another beneficial result in that we have decreased the friction load on the bearings. Assuming that the belt when standing is under a strain of 25 lb. per inch of width, easily obtainable; $25 \times 6 \times 2 = 300$ lb., this transmitted to the bearings, which might probably be $2.5 \times 7 = 17.5$ sq. in. $\frac{25 \times 6 \times 2}{2.5 \times 7} = 17.1428$ lb. per sq. in.

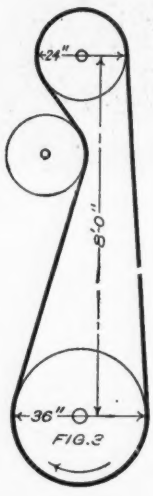


FIG. 3.

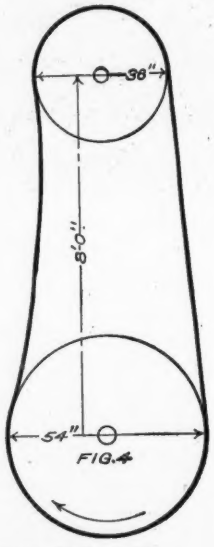


FIG. 4.

FIG. 3. VERTICAL BELT WITH IDLER
FIG. 4. VERTICAL BELT RUN ON LARGE PULLEYS

In the second case there would be only 3 or 4 lb. per in., little more than the strain due to the weight of the belt. Taking the larger figure $\frac{6 \times 2 \times 4}{2.5 \times 7} = 2.7428$, say 2.75 lb. per sq. in., a difference of 14.4 lb. per sq. in.

When running, of course, the pulling side takes most of the strain carried at rest by both sides, and in addition to this the load on the machine. If tight, the belt loaded to or exceeding its capacity, gives constant trouble by slipping and burning or running off and occasionally breaking; if lightly loaded, its life is shortened, and in addition to this the bearings wear very fast.

At one time, the writer, wishing to test the matter by an experiment, connected a small motor to a small machine in such a way that the tension on the belt could be easily varied. With belt slack the motor

could run the machine up to speed; increasing the tension on the belt, the speed was reduced until the belt was very tight and the motor was unable to run at all.

A Bad Case

There are exceptional cases, due to bad design, which cannot be changed without great expense and must be endured. For instance, a belt drive in charge of the writer was designed to transmit power from a new to an old system of shafting. The engine room having been moved to a new location made it necessary to run the old shafting from the end opposite to which it was formerly driven, this being done several years previous to the writer taking charge of the plant, and the following conditions prevailed: On the new shaft (Fig. 3) was a 36x20-in. driver; on the old, 8 ft. above it, a 24x20-in. receiving pulley. On what should have been the slack side of the belt was a 20x20-in. idler, held in by 2 long threaded rods turned by 12-in. hand wheels.

According to report, the first belt was an 18-in. 2-ply, which soon wore out, and a 3-ply was substitut-

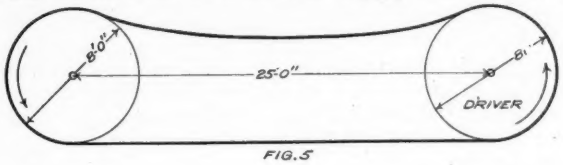


FIG. 5

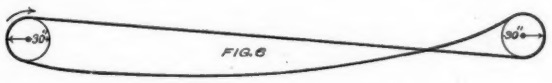


FIG. 6

FIG. 7

FIG. 5. MAIN DRIVE BELT
FIG. 6. CROSSED BELT
FIG. 7. BELT DRIVING A PUMP

ed; the writer arrived when this was about half worn out and had troubles of his own until it was replaced by another 3-ply which worked very well for a few months; then it too began to crack and otherwise deteriorate. The result of bending such a thick belt over a 24-in. pulley besides the turn in the opposite direction over the idler can well be imagined.

The Remedy

After having considerable repairing done, it was decided to get a new belt and the writer succeeded in having a change made, Fig. 4.

A 54-in. pulley was put on in place of the 36-in. and the 36-in. put on the upper shaft in place of the 24-in., the idler removed and a new belt put on with a result entirely satisfactory. The belt speed being increased gave more power and the belt being longer, due to the larger pulleys, there was more elasticity.

This was done about 2 yr. ago, which was about the length of time that the other belts lasted, and the belt is now almost as good as new. Some time ago it was necessary to shorten it as it was becoming entirely too loose for such a thick, vertical belt, and would not hug the pulleys. There is, however, a decided sag to the loose side. As it is in a place at times dusty, it is necessary to give it an occasional dressing to keep it soft and pliable, which is all that any belt should require.

Some Real Examples

Figure No. 5 shows the main drive, a 26-in. 2-ply belt, running from an 8-ft. flywheel to a receiving pulley the same size, 25 ft. between centers and a sag of 32 in.

Figure 6 shows a crossed belt, a 9-in. 2-ply running over 30-in. pulleys. Although the shafts are about 9 ft. above the floor it was so loose that the men were complaining about having to dodge when passing under it, in fact the sag was fully 2.5 ft. below the receiving pulley. Owing to its being troublesome to the men it was shortened a little.

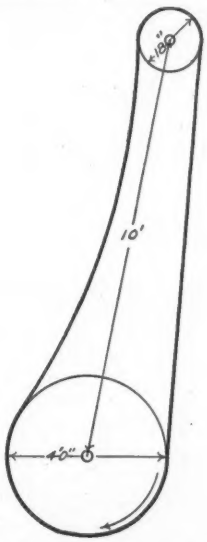


FIG. 8. NEARLY VERTICAL BELT

Figure 7 shows a belt which drives a double plunger pump. As the power required is variable, ranging from mere friction load at the centers to maximum a second later, it is trying work for a belt, but this is so loose as to allow the top to strike against the bot-

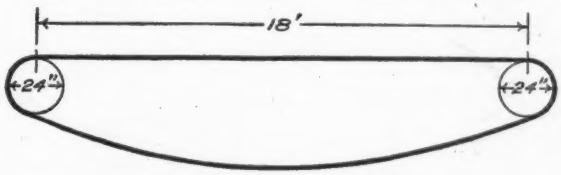


FIG. 9. TOP PULL BELT

tom at times. It is a 6-in. double belt running from a 20-in. driver to a 16-in. receiving pulley, with 12 ft. between centers.

Figure 8 is a 16-in. double, nearly vertical belt from a 48-in. to an 18-in. pulley. With only 10 ft. between centers it has a sag of 10 in. It drives an 8-ft. B. F. Sturtevant Co. blower, which furnished the air for a heating system which supplies a large part of the shops. Having a steady load, this belt runs with hardly a quiver. With the exception of the main drive, all of the above belts run in dusty places, but Fig. 9 shows a belt which besides having dust at times, is also exposed to considerable dampness. It drives what is known as a "sagger pug mill," a machine which requires considerable power as the material run through it is of a tough, sticky, "dead" nature. This material is prepared by soaking in a large concrete pit, over which the belt runs, and in winter it is necessary to use hot water to prevent freezing and the vapor

arising is rather detrimental to the belt, but in spite of this, very little trouble is experienced. It is a 9-in. double belt, running over 24-in. pulleys, with 18 ft. between centers with 24-in. sag, and shows that even with a top pull a belt taken care of and kept soft and pliable will give good service. Of course the same belt with bottom pull will transmit more power, but the effect on the bearings will be about the same.

These are only a few of the many similar belts in charge of the writer and all measurements are as accurate as possible. The aim of the writer has been to keep belts in a soft natural condition, and while emergencies may at times require special treatment with a sticky dressing, there are several safe and simple dressings which give good results in keeping belts in proper condition.

Fastenings

It is impractical to have all belts endless, a good quiet, smooth-running belt joint cannot be secured with any-old-kind of fastening. Having experimented with various kinds of lacings, including wire, also hooks of different kinds, the Crescent Belt Fastener, of an entirely different type was tried with very good results. It consists of plates and split, copper-plated steel rivets. The ends of the belt are cut square by using a small carpenter's square and brought together, the plate placed even and the rivets driven through holes, into the belt and then clinched. After running a few hours the joint cannot be noticed and what is still better none have yet been known to pull out, even after a few years' use. If required to shorten the belt it is only necessary to remove one row of rivets and after cutting replace with new ones.

The writer always places a new belt with the hair side next the pulley and also runs the belt in the direction which will smooth the joints should any loosen.

A little care taken in making square joints and keeping belts soft, particularly new belts, will well repay one for the little extra trouble.

THE HIGHEST FLIGHT OF A BALLOON

The unprecedented elevation of 95,250 ft. or 18 mi., was attained by an unmanned registering balloon, which was recently released at the Belgian meteorological institute at Uccle. At this elevation the barometric pressure is only 2/5 in. The greatest height ever attained by a manned balloon is about 6.7 mi., or 35,400 ft. The Berlin aeronauts Berson and Suering, who established this record, were unconscious when they reached the highest point of their flight.

The Belgians adopted Hergesell's plan of attaching the instruments to a small and partially inflated balloon, suspended from a larger and fully inflated one. The large balloon rises until it bursts, and the small balloon falls slowly, so that it can be easily observed and brings the instruments safely to earth. At the maximum elevation, 18 mi., the thermometer recorded a temperature of —82 deg. F., but a lower temperature, —88.5 deg. F., was registered at the comparatively small elevation of 8 mi. These observations appear to support the hypothesis that some of the ultra-red solar radiation is absorbed by the higher strata of the atmosphere, but additional observations will be required to solve the question.—Scientific American.

As the result of experiment, processes for preservation of timber have been so well developed that the life of almost any wood exposed to the action of the weather or buried in the earth can be at least doubled by thorough impregnation with creosote or zinc chloride.

STANDARDIZING OF RECIPROCATING ENGINES

For use with electric generators it has been considered desirable in England to standardize engines and the Engineering Standards Committee has taken up the matter and tried to remedy some of the confusion as to meaning of terms and sizes. For steam pressures they have suggested the following, measured at the throttle:

	Pounds per Square Inch Gage Pressure
Low pressure	100
Intermediate pressure	150
High pressure	200
Extra-high pressure	300

In the matter of vacuum, measured at the engine by mercury gage:

	Pounds per Square Inch, Absolute.
Medium vacuum	2.5
Good vacuum	1.5

Speeds of engines have been suggested for the usual designations, slow, medium and high with reference to rated capacity:

Rated Output in Kilowatts	Revolutions per Minute at Rated Output		
	Slow	Medium	High
30	...	...	625
40	...	...	600
50	...	...	575
60	...	...	575
80	...	...	525
100	107	250	500
150	107	250	428
200	107	250	375
250	107	250	375
300	94	214	375
400	94	214	375
500	94	214	300
750	83	188	250
1000	83	188	250

For engines driving generators it is suggested as a general rule that the engine shall be capable of driving the generators continuously at all loads up to the rated output and for at least 2 hr. at 20 per cent above the rated output of the generator without undue heating of the bearings, or other mechanical trouble. Also that the size of engine cylinders shall be such that the mean pressure in pounds per square inch referred to the low-pressure cylinder at full load shall not exceed that indicated below:

Steam Pressure, Pounds per Square Inch	100		150		200		300	
Class of Engine	Compound	Triple	Compound	Triple	Compound	Triple	Compound	Triple
Noncondensing	35	..	41	42	51	48	59	56
Condensing, medium vacuum ..	32	29	40	36	45	40	50	45
Condensing, good vacuum	30	27	37	34	41	37	46	41

Speed variation is limited to 5 per cent of the full load speed, when the load is changed gradually, i. e., by steps not over 20 per cent of the rated load.

HOW THE NEW CHIEF MADE GOOD

GETTING MUCH NEEDED NEW APPARATUS

By George H. Wallace

AFTER the verbal duel between the new chief, George Willard, and John Gautelbeim, the general manager with a grudge against himself, in which the latter "took water," the chief and Supt. Mather withdrew from the directors' room of the firm of Baum & Gautelbeim, where the board was in session, to the railroad yards of the works close by, feeling that it was much safer than in the same room with John and his linguistic dynamite.

As they reached the middle of the yards, they came to a halt and looked at each other for some time.

"Mr. Willard," said the superintendent, "I guess that you gave the G. M. a dose of his own medicine."

"No," replied the chief, "not a dose of his own medicine, but rather an opiate. You know that if you give a torpedo boat a dose of its own medicine, there is liable to be something going on shortly. But that is just a passing incident. Every dog has its day. John didn't have his when he was a puppy, so he has got to take his own medicine now. He has bluffed and bullied all his life, I should say. Every man's life has lots of bumps in it. The man who can get bumped good and plenty and look pleasant stands a good chance to succeed. Herr Gautelbeim couldn't bump the bumps and smile to save his life."

"But come on, Mr. Mather," continued Willard, "let us proceed with our inspection of the motive power end of this concern, where we left off to wait upon the Honorable Board of Directors. First of all, Mr. Mather I want from you a candid, open, confidential opinion of this firm as to future development. Is there frame work here, in your judgment, upon which to build a paying business?"

"Yes, I believe there is," said the superintendent, "but it is an uphill job made doubly difficult by the opposition of the ignorant head of the firm standing in his own light. But I have sufficient confidence in the future to set the mark 3 yr. from today—maybe less—but in 3 yr. from today Mr. Willard, with your help, I will put this plant on a handsome dividend paying basis in larger and better equipped buildings. It is part of my contract with the firm that I must be consulted on any proposed new ventures, which will prevent them from undoing all the good that I may be able to do for them, and I am going to reconstruct things entirely for ultimate good—that is, unless some of those old job lot boilers of yours take a notion to let go some day and bowl a few of us over on the way out. But why do you ask, Mr. Willard?"

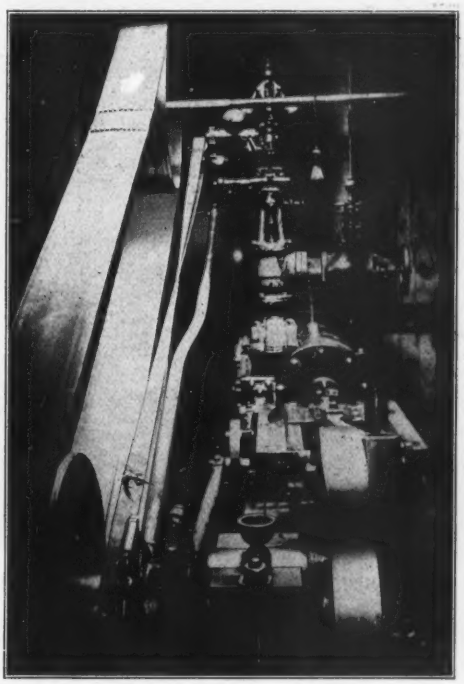
"Well," said Willard as he let his gaze rest for a moment on the exhaust pipe of one of the old engines which had "lost its vacuum," "I wanted to know what you intended to do so as to know what I'll have to do to keep up with you—or a little bit ahead of you. But by the time you have your factory rebuilt, I want a new powerhouse down there along the river at the lowest point on the premises, about where those old wagons stand. By the way, those wagons are beyond repair, absolutely, and will make steam and scrap iron. That will help a little towards buying several thousand horsepower of engines."

"Yes, Mr. Willard," said the superintendent, "if we are going to do anything at all, we might just as well start right in now and clean house. We can't make matters any worse and the chances are all in our favor to make them better. Can you use those shavings to advantage?"

"Yes I can use those shavings if you get them to the No. 1 boiler room," replied Willard.

They smiled cheerfully and shook hands; and right then and there in the railroad yards of the works, Superintendent Mather and Chief Engineer Willard began to pull together in a manner that in a short time was to make the name of Baum & Gautelbeim known at every country cross roads and at every port of entry in the western hemisphere.

Together they walked towards the engine room which had attracted the critical eye of the new chief a few minutes before. This engine was 15 by 27 in. cylinder dimensions, and had run on the same spot since 1854, in which year it was built at the old "Dickson"



THE ORIGINAL ENGINE OF THE WORKS

plant (long since gone out of business) close to the works. It was the original engine of the works.

As will be seen it is of the antiquated box-bed type, with a slide valve. The power is delivered from an extension of the main shaft extending through the wall into the factory proper. The belt shown in the illustration runs but a small part of the works.

As originally designed, the valve cut off at exactly 11/12 of the stroke and had always done so. The engine had an old flyball governor of antique design, which with the ill-designed valve had disposed of many a ton of good steam coal in the 51 yr. which had constituted its labors up until that time.

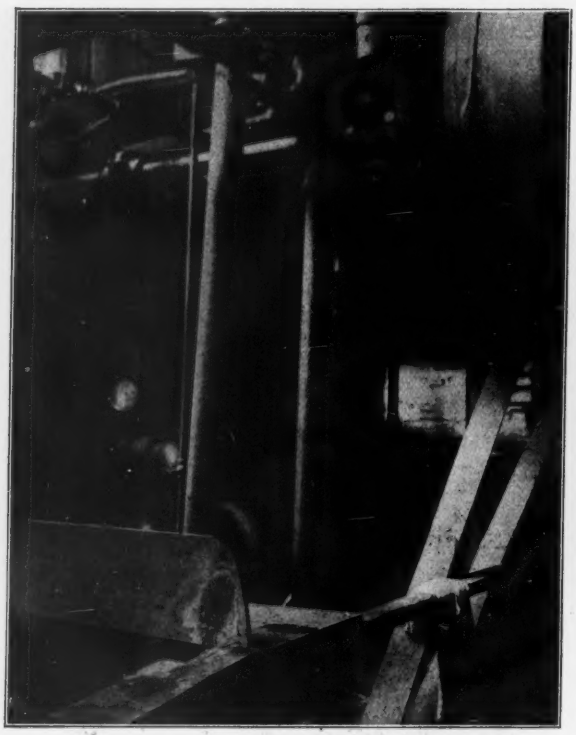
The first expenditure that Willard made around the plant was for a Nordberg poppet valve governor for this engine, which is shown in the illustration. This

assisted materially in reducing the fuel bills. While the governor was being attached to the engine, an exhaust fan had been installed to remove all shavings, etc., from the wood shops and deposit them in the boiler room.

The engine was supposed to run condensing—which it did by spells. The condenser was of the old original jet type and was carefully stowed away in a dark corner surrounded by a tangled mass of piping.

The steam supply pipe for the condenser pump was taken out of the bottom of the header of the boilers and as they primed frequently, the mud, etc., finally found its way to the steam cylinder with disastrous results.

One day the condenser just simply laid down and died, and the usual crow bar grease and monkeywrench



THE CONDENSER WAS OF THE OLD ORIGINAL JET TYPE

oil which Emil Lundgren, the engineer in charge, applied together with some forceful language, failed, and the pump refused to budge.

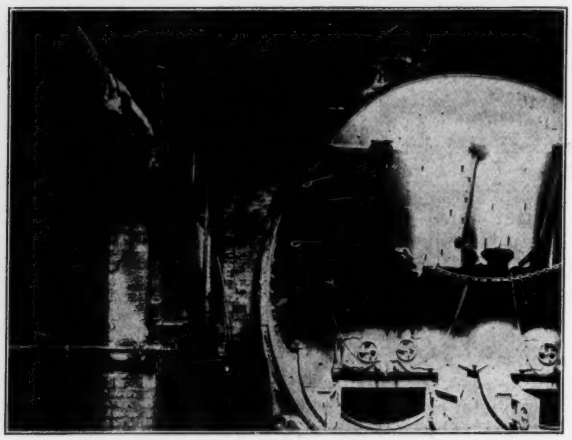
Upon examination it was found that the mud in the steam had worn off the top of the bridges between the posts about 1/64 in. which allowed live steam to blow over through the exhaust and to the condensing chamber.

During the 3 days that repairs were being made, there was a saving of 2100 to 2200 lb. of coal a day, according to the log book which Willard inaugurated, and this in view of the fact that live steam was used to heat water for industrial purposes, which had formerly been supplied by the condenser at about the right temperature. This is one instance where the condenser was a detriment instead of a benefit.

Three weeks later, the evil spirit again overtook the condenser pump for with a slam and a chug it stopped short again while the relief valve opened and the exhaust of the engine escaped to the atmosphere in a steady roar. This time it was the water end. Upon examination there were found 57 pieces which formerly had been the water piston. The number was remembered on account of the 57 varieties of Columbus Dill pickles.

The pattern shop was prevailed upon to make a wooden head by using half inch boards of maple and basswood laying them alternately to the right thickness (about 4.5 in.) with the grain set at about 60 degrees to give strength. Continuous service had left a large shoulder at each end of the liner and the wooden head was turned in a lathe to a size that would just drive in. When in place and the back head put on, the water swelled the basswood to fill the barrel nicely, and it ran for over 3 weeks, pulling up a vacuum of about 11 to 12 lb. when for several years 5 or 6 was considered the limit. In due time the new liner and piston head for the water end arrived from the works and another corner was chopped off the expense account.

"Mr. Gautelbeim," said the chief one day, as he walked into that gentleman's private office, "I find one of the boilers over in No. 1 boiler room is in a most dangerous condition and is—or was—liable to let go almost any time. I want a new boiler."



IT WAS OF THE 2-FURNACE SCOTCH TYPE

"Can't have it!" stormed the G. M. "That boiler is all right. The man I bought it from 18 yr. ago told me it was in first class condition and I won't buy a new boiler for you or anybody else. When I want one I'll buy it myself. I know just where I can buy boilers cheap."

"Mr. Gautelbeim," said that same quiet firm voice, as the stern brown eyes of the chief pierced the cold gray ones of the manager, "I came in here to get a new boiler and you are going to get it for me. I found that there are 22 rivet cracks in the seam over the bridge wall of that boiler. I also found the old lever safety valve leaking and weighted with scrap iron till it would take 209 lb. to raise the valve. That is a 70 in. shell of 5/16 steel, that is badly pitted and grooved. I have reground the safety valve and reduced the usual pressure of 95 lb. to 75 lb. on the old boiler and separated the boilers, raising the pressure on the newest one to 110 lb. which is well within its capabilities, and putting it on the engine and pump alone. The old one at 75 lb. runs the condenser, fire pump, fan engine, dynamo engine and as much heating as it can. Do I get the boiler?"

"But I paid good money for that boiler!"

"Haven't the slightest doubt about it, Mr. Gautelbeim," replied Willard, "but if you have charged up the proper amount to depreciation in the meantime,

that boiler has paid for itself 8 yr. ago. And besides," continued Willard, "I've got to get a larger boiler than the old one to supply increased demands for power. And we might as well put in one to help out the old plant, that we can use in our new power plant in a couple of years."

"What new power plant?"

"The new power plant that you are going to build down along the river in about 2 yr."

"First I heard of it!"

"Well, it wont be the last you will hear of it, either, Mr. Gautelbeim, I came in here to talk business; not to juggle mere words and fence with more or less elegant expressions," (old John winced at this). "Now please call up Freeman's Boiler Works and ask them to send a level headed salesman over here and we'll talk the matter over."

Gautelbeim tried to go up in the air again but that quiet voice, the brown eye, and the heavy jaw only reminded him of his own weakness and—well—they bought a boiler. It was of the 2-furnace Scotch type built for 160 lb. working pressure and to develop 250 boiler horsepower. This boiler formed the nucleus for the new power plant.

THE NEW FEED WATER HEATER

Water had been entering the boilers at 105 to 110 deg. F., being heated by an antiquated closed heater placed enroute from the engine to the condenser, or as Lundgren expressed it, a carbuncle on the exhaust pipe.

But the hand of time had not dealt as kindly with the heater as it had with the remainder of the plant, which is not saying much, and a close inspection revealed decay bordering on the verge of catastrophe, and a choice collection of copper tubes that would put gladness into the eye of any wandering Solomon Levi that ever drove a decrepit and aged horse, more or less securely attached to a "democrat" wagon.

The old heater sold for enough within about $20 to pay for a new one which was installed as shown in the illustration. "We can use that heater over in the new plant I think, Lundgren," said Willard, and Emil smiled, spit on his hands and got busy with the scoop shovel.

With these few little improvements made, and others well under way, the vultures which for years had floated in the air over the dying carcass of the firm of Baum & Gautelbeim waiting for it to yield up the ghost that they might gorge themselves on the carrion, flapped their lazy wings and sought shelter in the desolate wilderness of a distant swamp, while the dove of peace came and took refuge on the office window sill and cooed to its loving mate.

(To be continued.)

CLEANING OFF NEW ENGINES

By C. R. McGahey

SOME one in the factories should draw the line on the way the goods of some high-grade enclosed self-oiling engine builders are being shipped out: from close examination of some of them built in the east as well as in the west, it is not uncommon to find much loose burnt sand adhering to the interior of these engines; the writer has observed this condition in several cases. If the factory ships units out in this condition, what can be expected from the operation.

Only recently in examining one of these machines sufficient loose sand was adhering to the crank oiler, which was a casting, to ruin the interior or do more damage to the crank than a year's run should do. In one case the engine was badly damaged, which was credited to a poor attendant, when the whole blame should have fallen on the manufacturer, for the party starting the engine was the one at fault.

It is a well-known fact that oil will loosen burnt sand from the casting and this soon works all through the bearings of the engine, getting them rough, and making the engine troublesome from the very start. From practical observation I would warn every engineer to clean the interior of the oil-bath engine carefully for his own benefit.

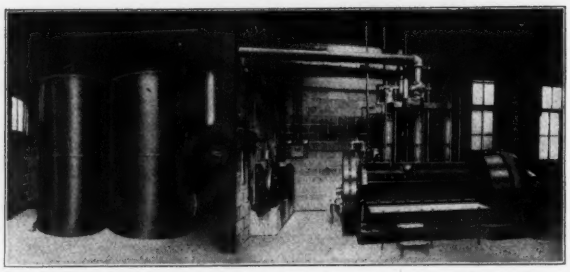
The castings for the interior, as well as the main frame, should be pickled just as some builders practice. This process will lift the sand scales and prevent such conditions as we have found in many cases, a small expense to the builder and a great gain in the satisfactory starting off of the engine.

I have observed a practice followed by some of the builders which appeals to me and that was the painting of the whole interior surface of the frames and working parts with some kind of enamel paint. The painter would naturally clean out loose sand before painting and this leaves a clean surface for the engine's initial starting. This struck me as a good idea.

We had occasion to redress a set of cast crankpins on a cross compound self-oiler from this cause. It does not require much grit to start a new cast crank on the "war path"; when once glazed the pins are not so sensitive as they are when they leave the factory. The erecting man and engineer can save themselves by going over the interior of this class of engine before trying to break them in. I am sure the field engineers will sustain me in this effort.

THE LUCANIA, which was the first vessel to make the transatlantic trip at more than 22 knots an hour, was recently burned, as already noted, and will not be repaired, but will be discarded and replaced by a new turbine ship of 25,000 tons.

Gas Producers



And Engines

TESTS ON GRAND RAPIDS HYDRAULIC CO.'S PUMPING STATION*

By James R. Fitzpatrick.

Terms of Contract

THE contract between the Minneapolis Steel & Machinery Co. and the Grand Rapids Hydraulic Co. called for the installation of 2 100-hp. Muenzel gas engines, 1 No. 8 Muenzel gas producer having 46 in. grates, (the No. 7 producer had been installed a year previous), 2 3-stage centrifugal pumps each with a capacity to pump 1,000,000 gal. of water in 24 hr. at gage pressure of 120 lb. at the pump. Each engine was guaranteed to be capable of operating each pump to its full capacity.

The company guaranteed that each engine would deliver 1 hp. hr. on 1 lb. of pea anthracite coal on any load between 75 to 100 hp., and on 1.5 lb. on any load between 50 to 75 hp., provided the coal had a calorific value of not less than 13,500 B. t. u. The engines were guaranteed to regulate within 2 per cent of normal, under all natural changes of load. It was also guaranteed that the banking of the fire should not require more than 20 lb. of coal an hour.

The No. 8 producer was guaranteed to be equal in capacity, workmanship and material to the No. 7 producer, purchased in January, 1907. The usual guarantee as to workmanship and material for 1 year was given.

The contractor was relieved of the pump guarantee when it was decided to install triplex pumps instead of 3-stage centrifugal pumps. The pumps were guaranteed by the manufacturer, the Deane Steam Pump Co., to deliver 1,184 gals. per minute against 100 lbs. pressure, at 40 r. p. m. An efficiency guarantee of 78 per cent was made, also the usual guarantees as to workmanship and material.

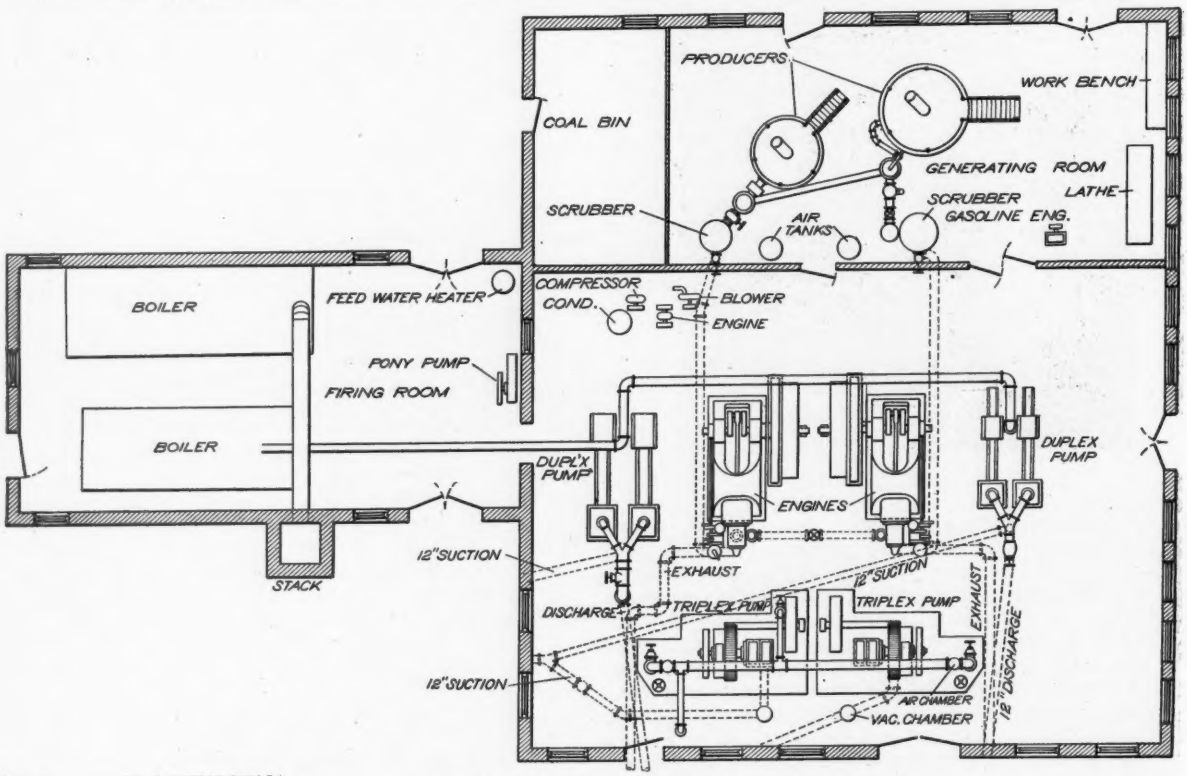


FIG. I. PLAN OF POWER HOUSE

Dimensions

The object of the test was to determine if all these guarantees had been fulfilled; also to determine the general efficiency of the plant. The producers are

*Abstract from a paper by James R. Fitzpatrick, C. E., General Manager of the company, presented at the American Water Works Convention, Milwaukee, Wis.

known as the No. 7 and No. 8 Muenzel producers. Both producers have the same size grate area, 46 in. diameter, but the No. 7 producer has a 56-in. fire pot and the No. 8 a 48-in. fire pot. The No. 7 producer's over all diameter is 6 ft. 6 in., and the No. 8 5 ft. 10 in. The No. 7 producer is 10 ft. 3 in. high, and the No. 8 is 7 ft. 6 in. The No. 7 producer has a separate vaporizer, and the No. 8 has a superimposed vaporizer. The No. 8 producer has a removable grate platform, the grate platform and ash pit sliding out on rails. The No. 7 producer has not this arrangement, consisting of one complete shell.

Only wet scrubbers are installed, they being cylindrical steel shells, each 3 ft. diameter, and 10 ft. high. The starting devices consist of a type A Olds gasoline engine, 2.5 hp., a blower, and a single cylinder air compressor, the air storage tank being 24 in. by 5 ft.

The engines are the Muenzel, single cylinder, 4-cycle with 18¾-in. cylinder and 28-in. stroke. One engine is right, the other left hand. Each engine is guaranteed to be 100 hp. capacity, at 190 r. p. m.

The pumps are the vertical, double acting, triplex pumps of the Deane type, one right and one left hand. Each has a 12-in. stroke, and 11 in. cylinder. The pumps are belt driven from the engines, the belts being 14 in. double, extra heavy stock, running 30 to 33 oz. to the foot, and are made of short lap oak tanned leather. The gas engine pulleys are 86 in. diameter and the belt pulleys 80 in. The pumps are geared 4.64 to 1.

The test was conducted on June 1, 2 and 3 by the writer, who represented the Grand Rapids Hydraulic Co. J. J. Werner, mechanical engineer, of Grand Rapids, represented the contractors.

It was the intention to test one of the producers from cold start, and the second, which was in operation at the beginning of the test, was to have been tested from a hot start. The producer that was then under fire, however, had been running steadily for 11 days previous, and began to show signs of a deterioration of gas, the engine lagging occasionally. Fearing a possible shut down in the middle of the test, it was decided to clean this producer also, and test both plants from a cold start.

Being cross connected, the conditions at the time of the start necessitated running No. 1 engine from No. 2 producer. Upon completion of the 24-hr. run, No. 1 producer was put in operation, and furnished the gas to drive No. 2 pump.

As the test was made under working conditions, and as we are required to operate 24 hrs. daily, we were unable to determine definitely the brake horsepower. We assume an engine efficiency of 85 per cent, and the test then was made by firing each producer in turn, running each approximately 24 hr., and then pulling the fire and weighing the salvage. The No. 2 producer was given 2 runs, one of approximately 24 hr. and one of about 3 hr. Between these runs the producer was banked, so that we could make a bank test.

It was impossible for us to determine the slip of the pumps. The pumps are new and have been in operation but 2 months. A close examination failed to show any great slippage, so the slippage of pumps was assumed at 5 per cent, which we think is an outside figure. Our standpipe is several miles away from the pumps, and the system is direct pumping, with the standpipe to take care of the surplus so that although we could pump into the standpipe, it would not give us any correct indication, inasmuch as there are many heavy users on the main line, before it reaches the standpipe.

The gages, meters and scales used during the test were tested and found to be correct. In determining stand-by loss, the No. 2 producer after completing its first run was thoroughly shaken, the lower doors opened at the grate, and all ash and clinker removed that could be. The height of coal above grate was then measured. The producer was allowed to stand, all doors and poke holes being closed tight, and no coal added for 20 hr., at which time the producer was again thoroughly shaken down, and the height above grate measured. The difference was 2 in., and knowing the interior diameter of the fire pit the cubical contents were determined. This 2 in. of coal burned was considered as dry partially burned coal, and a determination was made to get at its weight per cubic foot.

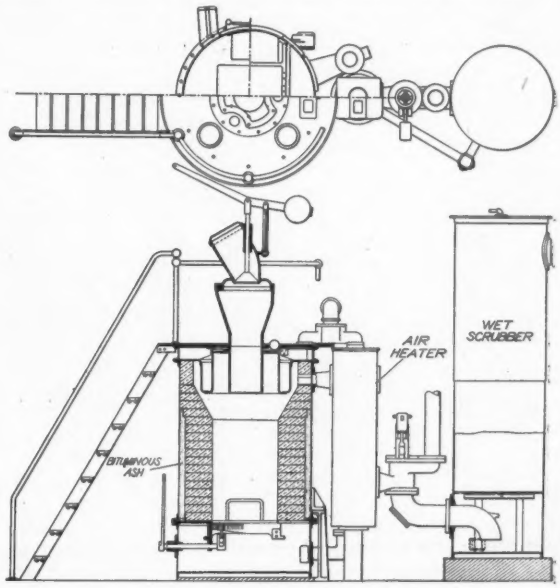


FIG. 2. SECTIONAL VIEWS OF PRODUCER

After each producer had made its run the fire was pulled. No account was taken of the ash, as we simply wished to determine the value of the salvage, meaning the coal that we can again use in the producer.

A determination was made to get at the difference in weight between a cubic foot of dry unburned coal, and dry partially burned coal, and wet partially burned coal, and it was found that the wet coal weighed 8.3 per cent more than the dry partially burned coal, and the dry partially burned coal weighed 3.3 per cent less than the unburned coal. For making this determination the net value of the salvage, considered as good coal was determined.

No. 1 pump when put in operation caught its prime, and started pumping water in 5 min. No. 2 pump did the same thing in 4 min. The tests were considered to have begun at the time the pumps started doing work. The time the engines were running light was considered as stand-by loss. It was necessary to shut down in order to remove the indicator reducing motion from the engine. The reducing motion was removed and the engine put in operation, and the pumps started pumping in 7 min., which, however, is an unusual record.

Following the completion of the test on No. 1 producer and the drawing of the fire, the producer was thoroughly cleaned, refilled with coal and put back in

operation in 3 hr. 24 min. This necessitated the handling of all the salvage and the filling of the producer for the new run with approximately 1 ton of coal, all of which had to be handled in buckets, carrying 80 lb. each.

We were unfortunate in having the revolution counter on pump No. 2 get out of order during the middle of the run, on this pump. Careful determinations had been made, however, of the revolutions per minute of the engine, the pump pulley and the pump crank, and from these readings an average of the speed of the pump was obtained. We had an accurate determination of the speed of pump No. 1, and pump No. 2 was found to be within 0.6 of a stroke per minute the same as pump No. 1. A comparison of the revolutions of the 2 pumps during the time that the counter on pump No. 2 was in working order showed that during the corresponding hours pump No. 1 was running at a slightly greater speed than pump No. 2. This slightly increased speed of pump No. 1 over pump No.

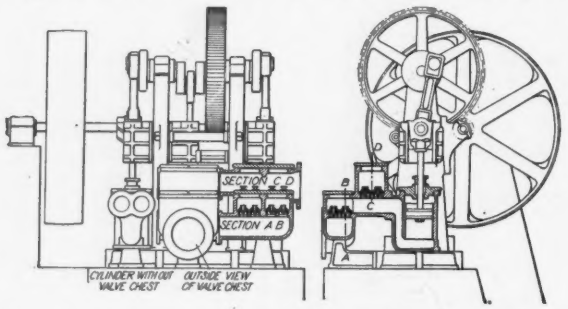


FIG. 3. VIEWS OF TRIPLEX PUMP SHOWING ARRANGEMENT OF CYLINDERS AND VALVES

2 was constant throughout the first 24 hr. of the test, and for that reason we believe that the final speed of pump No. 2, which is slightly under that of pump No. 1 is correct. All readings were taken every 30 min. except when the counter of pump No. 2 became out of order, after which readings of the revolutions of this pump were taken at 15 min. duration. No effort was made to determine the amount of water that the vaporizers and scrubbers used separately.

Result of Test

The results found are high, but based on all figures ascertained and on the assumption taken, the figures are correct. The stopping of the revolution counter during the test of one engine was unfortunate, but a careful study of the figures obtained for pump No. 2 will not show much difference from pump No. 1. In reference to the test of pump No. 1 there are known positively the average pressure, the total displacement, and the total coal burned, so that the duty of this unit during the test can be found accurately. The duty is higher even than the average for the plant.

During the month of May a careful record of coal consumed, average pressure and total plunger displacement was kept. During this month the counters were on both pumps and in working order. After allowing for all water used for cooling purposes, 5 per cent slip of pumps, which is probably high as the pumps are new, and based on total coal consumption for the month, the duty figure is within 5.5 per cent of the test duty figure.

During the recent test a total of 3,412,982 gal. plunger displacement, was pumped against an average dynamic head of 237.29 ft. (103 lb.) with a total consumption of coal, including one producer banked for nearly 27 hr., of 4002.4 lb., practically 2 net tons of pea anthracite coal, at a cost of $3.40 per million gallons. With coal at $6 per net ton, the cost would have been $3.60 per million gallons.

During the month of May there was a total displacement of 50,169,712 gal. against an average dynamic head of 225.23 ft. (98 lb.), with a total coal consumption of 57,196 lb., slightly more than 28.5 tons, at a cost of $6 per ton. This made the cost per million gallons pumped, against a head 5 lb. lower than the test, $3.42.

Producers

	No. 1.	No. 2.
Type Producer.	Muenzel No. 7.	Muenzel No. 8.
Grate diameter, in.	46	46
Fire pot diameter, in.	56	48
Diameter over all	6 ft. 6 in.	5 ft. 10 in.
Height of producer over all	10 ft. 3 in.	7 ft. 6 in.
Height of grates to gas outlet	6 ft. 2 in.	4 ft. 6 in.
Scrubber diameter, ft.	3	3
Scrubber height	10 ft. 6 in.	10 ft. 6 in.
Rated horsepower	165	150
Length of test, hr. and min.	26-20	54-15
Time banked	0	26-58
Coal to start, lb.	1875	1080
Total coal used, lb.	3315	2760
Coal consumed per hour, lb.	79.2	65.5
Coal banked per hour, lb.	00.00	5.03
Coal consumed per brake horsepower per hour	1.1	.92
Time between stoking	2 to 3 hr.	2 to 3 hr.

Engines

Cylinder, in.	18¾	18¾
Stroke, in.	28	28
Length of test, hr. and min.	24-00	29-37
R. p. m.	157.5	155.7
Brake horsepower	69.22	71.35

Pumps

Diameter of cylinders, in.	11	11
Stroke, in.	12	12
Pump, r. p. m.	36.184	35.5
Elevation, ft.	206.65	216.28
Suction lift (including friction)	11.55	11.55
Displacement per minute, gal.	1071.84	1051.51
Efficiency of pump (less pump and belt slip	.86	.86

Plant Combined

Average g. p. m.	1060.7
Average g. p. m. cooling water	14.997
Average gage pressure, lb.	93.2
Average gage pressure, ft.	215.19
Suction, ft.	11.55
Gage elevation, ft.	10.55
Coal consumed per b. hp. h., lbs., less banking	1.005
Coal consumed per b. hp. h., lbs., with banking	1.04
Total b. hp. developed	3,846.9
Duty, less banking, slip and cooling water,	163,535,000

Summary

	Guarantee.	Test.
Producer operation—1 lb. per b. hp. h. between 75 and 100 hp.	1.005 per b. hp.	(70 hp.)
Producer operation—1.5 lb. per b. hp. h. between 50 and 75 hp.		
Producer banking—20 lb. per hour.	5.03 per hour.	
Engine hp.	100 b. hp. at 190 r. p. m.	86 b. hp. 168 r. p. m.
Pump efficiency	78	86.

THE NEW COOPER GAS ENGINE

THE manufacturer of this engine became convinced several years ago that in certain fields of work a thoroughly practical gas engine would prove advantageous. A careful investigation of the gas engine situation in this country and in Europe was immediately begun by this company. A few of the leading designs possessed special points of merit. None, however, combined all the good features which seemed essential to a continuously successful American engine. The company finally decided to design its own gas engine, and unite, if possible, all the best engineering features which modern practice had proven to be sound and desirable.

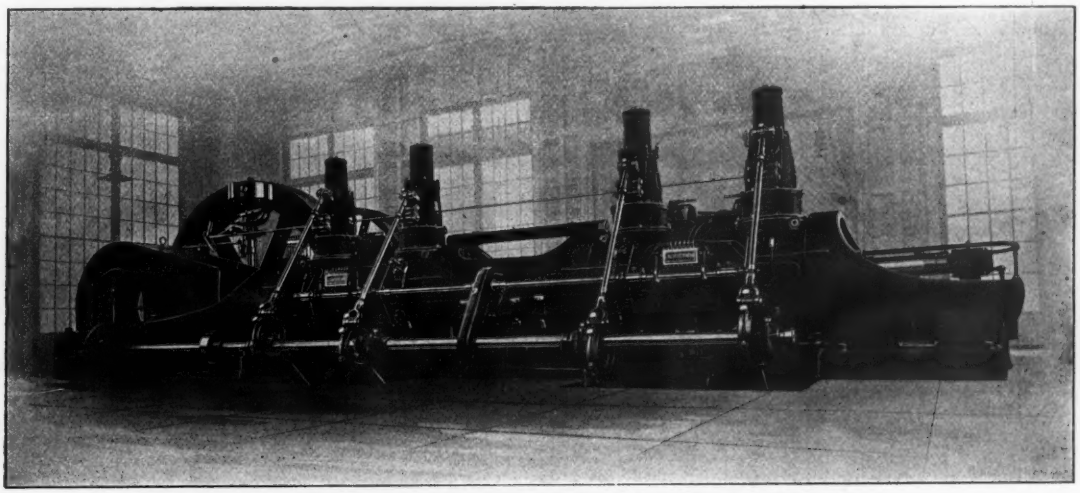


FIG. I. COOPER GAS ENGINE SHOWING VALVE GEAR

Martin A. Thiel, the well-known gas engine expert and designer, was selected to supervise this important work. Mr. Thiel's many years of experience in designing and building the largest and most successful gas engines operating in this country especially fitted him to accomplish the desired result. Mr. Thiel's wide experience also in operating large gas engine plants has proved valuable in solving with originality and skill many of the problems of gas engineering, such as ignition, timed lubrication, cooling and regulation.

Little publicity has been given the extensive gas engine developments being carried on by the Cooper Co., pending endurance tests in service of the new machines. The Cooper gas engine is now a demonstrated success, and is an accepted standard in the gas engine field. Its regulation, running qualities and general reliability have been proven to be equal to that of a steam engine of the highest grade; the thermal efficiency is of course far superior to that of any steam engine.

The New Cooper is a double-acting, 4-stroke cycle machine, working on the constant mixture principle. Both the air and gas are distributed from the center of the engine so that they travel equal distances and with equal resistances to the respective intake valves of the cylinders. The mixture in all cylinders, therefore, must be identically the same in volume and composition under all conditions of load. Upon a similar principle the cooling water is introduced into the piston rods from a central point, and passes through each piston and piston rod without reversing the flow, to the outlets at the forward and rear ends of the engine.

The overhanging counter-balanced type of crank has been adopted. The bed is of the heavy duty rolling mill type, having an open top, permitting access to the crosshead, and easy removal of the cylinder head and piston through the bed. The bed is rigidly bolted to the foundation, while the distance pieces and tail rod supports, which are of cylindrical construction, rest on base plates in machined ways.

The main bearing is of special design. The lower shell rests in a bored seat, and may easily be removed after relieving it of the weight of the shaft. This shell is babbitted and cored for water cooling. The side gibs are provided with wedge adjustment on either side, and are lined with babbitt. The cap is babbitted at the ends only, and is used to clamp the quarter boxes and the bottom shell into place. In addition

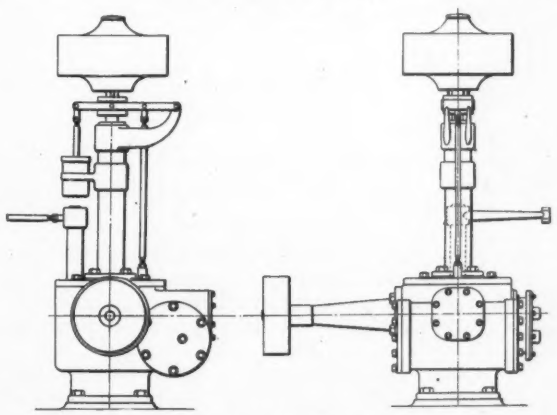


FIG. 2. AUTOMATIC OIL PRESSURE RELAY GOVERNOR

there is a transverse rib on either side of the cap extending the length of the bearing, which provides a retaining wall for the oil, and compels it to enter the bearing above the side gibs. The crosshead is fitted with an improved flat shoe, the top face of which is bored to allow the crosshead pin to align itself with

the crank pin, should the latter be thrown out of the horizontal plane by shaft deflection.

All pistons and piston rods are the same, and are interchangeable. The pistons contain no ribs and float on hollow rods between the main, intermediate and supplementary crossheads. The rods are nickel steel forgings, and are drilled for water circulation and forced into the pistons. The cylinders are 1-piece barrels, with inlet and exhaust chambers bolted to them, so as to remove all cooling strains in the castings. The water jacket is closed at its center by a belt in 3 segments.

The cylinders are supported only at the ends by the main bed and guide castings, and as the piston and rods are carried by their respective crossheads, the cylinder barrels are permitted to expand and contract with freedom. The exhaust piping is of flexible con-

FIG. 4. IGNITER OF COOPER ENGINE

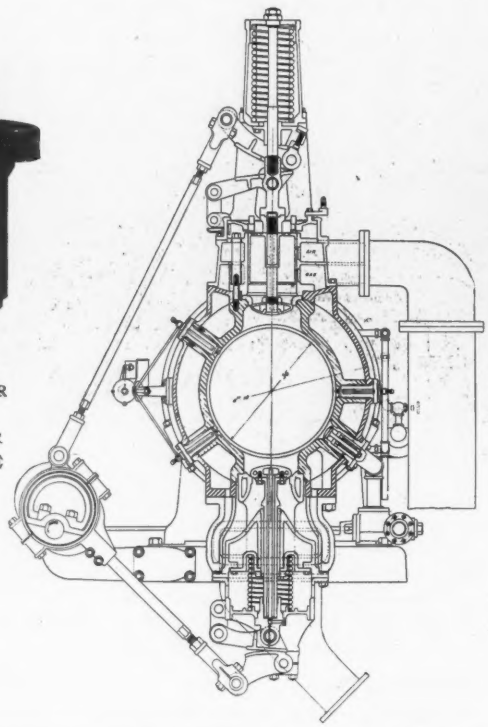


FIG. 3. CROSS-SECTION OF CYLINDER SHOWING VALVE GEAR AND IGNITERS

struction throughout, insuring free movement for expansion and contraction due to changes of temperature. The ignition is of the make and break mechanically operated type, and 2 or more igniters are operated simultaneously at each end of each cylinder. This system is connected with a safety stop, which automatically breaks the electric circuit when the engine speed exceeds 10 per cent above normal, or the cooling water supply fails.

The engine is regulated by varying the quantity of a constant mixture controlled by the governor through an automatic relay. The lay shaft is driven by spur and bevel gears. It is supported by bearings on the engine bed and base plates, thus avoiding the common practice of supporting it on bearings from the cylinders, where they are subjected to temperature changes, or from the foundation where it is difficult to maintain proper alignment. This self-contained construction has the additional advantage of permitting the removal of the cylinders without disturbing the lay shaft bearings. The inlet and exhaust valves at either end of each cylinder are actuated by a single eccentric on the lay shaft. The exhaust valve is of the separate cage water cooled type. The gas regulator is of a special oil-sealed enclosed construction with balanced valve.

Aside from the combination in this engine of features essential to the best results in a gas engine, the construction details common to all reciprocating engines, such as bearings, connecting rods, etc., have been worked out with unusual painstaking and skill. The design and performance of this engine has been regarded as remarkable by many prominent gas engineers who have inspected it. It bids fair to sustain, if not to advance the high reputation already held in the engine field by the C. & G. Cooper Co., due to the excellence of its steam engines. It is prepared to

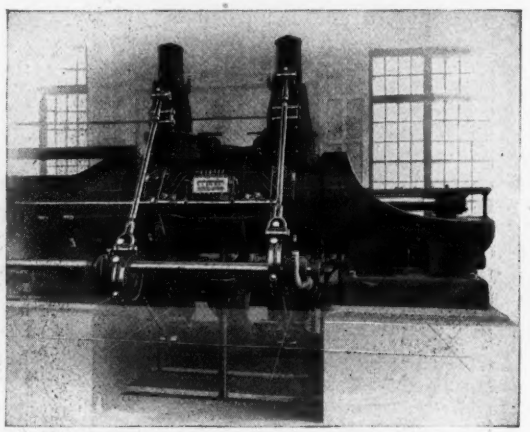


FIG. 5. EXTERIOR VIEW OF CYLINDER

build gas engines in single tandem and double tandem units of from 150 to 3000 horsepower capacity.

The C. & G. Cooper Company is one of the few large concerns now devoting its attention and facilities exclusively to the building of steam and gas engines.

FLOODING

"If a gas engine does not start on the first, second or third cranking, you had better try to find out where the trouble is."

This is what I have heard many times, but it is not true in all cases. In starting a small 2-cycle marine engine, which had a mixing valve in the place of a carbureter, and a jump spark, I noticed that it would not start on the first 4 or 5 turns, but after about 15 turns the engine would begin to give a few weak explosions every 4th or 5th turn. Later it would explode every 3d, then every 2d, and lastly every revolution, and the explosions would slowly become stronger and stronger until the full power was given. All this trouble was due to flooding on account of poor mixing of the gasoline with the air, and after a carbureter was put in the place of the mixing valve, little or no trouble was had in starting. A. E. L.

FOR CEMENTING HARD RUBBER TO METAL, Scientific American gives the following formula: Good cologne glue is boiled down to a thick fluid and enough sifted wood ashes stirred into this to produce a mass which is uniform but not too thick. If this is used warm and the pieces are put carefully together while drying a good joint will be secured.

LONDON LETTER

BITUMINOUS FUEL GAS PRODUCERS

By W. A. Tookey

ABOUT a year ago an engineer connected with a well-known British firm of gas engine and producer makers, stated that a successful bituminous suction gas producer equipment "will shortly be on the market." This announcement evoked considerable interest at the time, and a month or so later a few particulars were forthcoming with regard to the general features of the apparatus. But, alas! such information was accompanied by the statement that although very promising results had been obtained, the makers were not yet prepared to put the plant on the market owing to some minor troubles still requiring correction.

As far as the writer is aware the "minor troubles" have not yet been corrected. At any rate, no steps have been taken to exhibit its good qualities to the world at large. In view, however, of the recent introduction of a plant of this type, which, it is claimed, does operate successfully and which will be described later, it may be interesting to give a diagram and a brief description of the apparatus.

Operation of Generator

In Fig. 1 it will be seen that the fuel is fed on to a plate inclined at an angle approximating to the natural angle of repose of the fuel. This forms a thin bed of bituminous coal supported partially upon inclined fire bars fitted with a mechanically driven rocking device, and partially upon a rotary charging valve which passes the fuel at a uniform rate into the lower portion of the generator. A fire is started upon the inclined grate and by a controlled admission of air, the fuel is partially burnt in order to drive off all the condensable gases thus distilled. These volatile gases are conducted to the ash pit by a pipe which is also in connection with the water-vaporizer placed at mid-height. At the base of the apparatus the pipe is water sealed and the velocity of the gas in passing down, ensures that the major portion of the dust and heavier particles are thus trapped. An inclined branch leads into a conical fire grate in the center of the mass of incandescent coke, auxiliary air being admitted as required at the point shown.

The lower part of the generator was operated on the up-draft principle, and the whole scheme depended for its success upon the partial pre-combustion of the fuel; the conversion of the vapors given off during such process into fixed gases; and the extraction of any further tarry matters by mechanical separation in a belt-driven centrifugal fan.

Defects in Design

Looking at the general features of the design one can form an opinion as to the minor troubles that were likely to be experienced. The partial pre-combustion would require a large amount of air to be supplied in order to obtain a temperature sufficient to drive off any considerable proportion of the volatile constituents in the fuel. This would have a tendency to encourage the formation of clinker unless such temperature could be damped down by an adjustable supply of steam. Again, the coal would have to be carefully selected for its non-caking qualities, as with any rich coal which under the influence of heat exudes a sticky, spongy and plastic mass, one can imagine that the rotary valve would be likely to become set fast by the downward flow of tarry fluids becoming congealed at the lower temperature prevailing at this point, while it is conceivable that the fusing of coal into larger masses would probably require a considerable force to be applied to keep the small rotary valve from becoming choked.

The Morton Generator

Recently another type of bituminous fuel gas producer working on the suction principle has been put upon the market by George L. Morton of Sutton Coldfield, and a diagramatic section is given in Fig. 2.

The generator is worked upon the down-draft principle; the fuel being coked in the upper part; the volatile matters distilled off being dissociated and reduced during their passage through the lower layers of fuel. No mechanical appliances are needed, the necessary manipulation being only occasional poking and proper regulation of air and steam at the various openings to obtain equal intensity of combustion and to prevent the production of hard clinker.

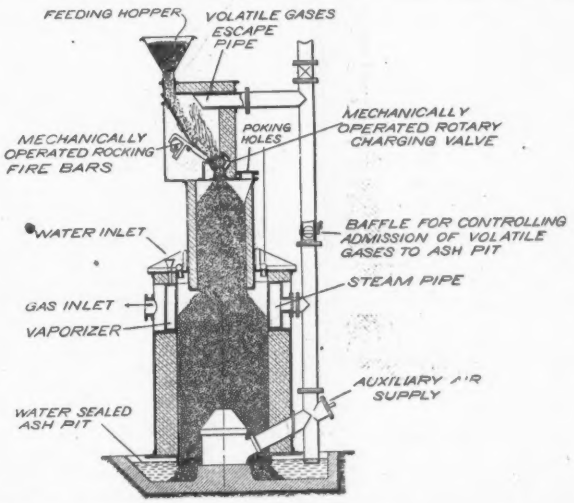


FIG. 1. PRODUCER GAS GENERATOR USING BITUMINOUS COAL

Operation

The generator is first filled with broken coke up to the level of the doors C C in Fig. 2. A fire is kindled on the top of this with wood, and a down draft established by means of a fan in the usual manner. As soon as gas is obtained, the engine may be started, and steam is then turned into the various air inlets of which a number are provided at different levels. As the coke settles down in the generator, bituminous coal is fed in through the cover H, and the volatile matters distilled by the heat of the incandescent coke in the portion marked A, are drawn down through the lower bed of fuel in B. It will be seen that a sloping wall, I, is provided at this point, the angle being that of the natural angle of repose of the fuel. This is to ensure that the fuel shall pack less closely against

this face and thus provide a path for the volatile constituents to pass freely downwards. Auxiliary air inlets are provided at each side of the generator at C^1 and also at the front C^2, to supply the oxygen necessary for the fixation of the tarry vapors, steam being used to moderate the temperatures as required.

From the angle at C^2 a reverse slope is provided so that the fuel will pack closely against the face and ensure the tarry vapors passing through the incandescent coke in B^1. At B^2, the gases converge and pass through the ash zone above the firebars F, being drawn away by the pipe E to the engine. Ash doors are provided at each end of D D and in the pit G.

During operation the cover H can be lifted and the fuel poked down from above, and it is particularly to

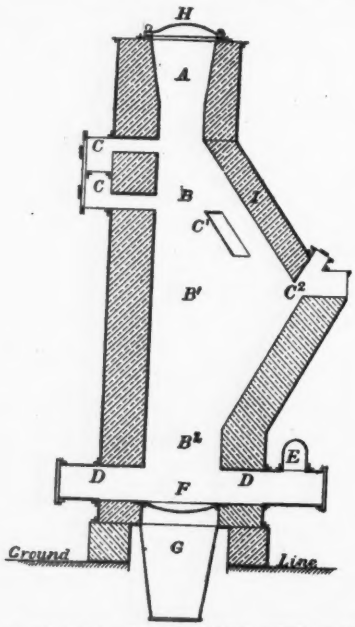


FIG. 2. THE MORTON BITUMINOUS FUEL GAS PRODUCER

be noticed, that while signs of tar are distinctly visible at the upper doors no trace of it can be detected round any of the lower doors; the scrubber water also shows no trace of tar.

After leaving the generator the gas is passed through a small multitubular boiler which generates enough steam to supply the generator. From thence it is drawn through a circular cooling tower consisting of a series of tubes, the gas being within the latter and water outside. After passing through a wet coke scrubber of the usual type, the gas is led to an expansion box placed close to the engine cylinder.

Results of Tests

From a test made at the Dudbridge Iron Works on May 26, 1909, with Warwickshire Nuts, 0.5 to 2.5 in. cube from near Polesworth, yielding 9.6 gal. of tar per ton of coal, the consumption of coal for 42 b. hp. developed for 6.5 hr. was at the rate of 1.11 lb. per b. hp. hr., after allowance was made for the coke used for starting and for coal burnt during standby hours.

Another test with this plant was from a Tuesday to a Friday, both days inclusive, for 10 hr. per day, with a Dudbridge single cylinder, horizontal, 4-cycle, hit and miss governed gas engine having 13.25 in. diameter cylinder by 21.5 in. stroke running 180 r. p. m. with a brake load of 38 b. hp. This engine is rated by the makers as being capable of developing a maximum of 55 b. hp. on illuminating gas and 42 b. hp. on anthracite producer gas. It was found that with bituminous fuel gas the maximum output was 48 b. hp.

The plant has also proved capable of giving satisfactory results under variable loads, for upon the day following the conclusion of the above trial, after running 35 min. with a load of 48 b. hp., 60 min. at 12 b. hp., and 10 min. at practically no load—the brake ropes being loose on the drum—the full load of 48 b. hp. was applied as quickly as possible, and maintained for 20 min. This sudden application of 48 b. hp was made without slowing the engine and the cut-out charges were 4 per minute. Finally, the load was again reduced to 12 b. hp. for 20 min. and again increased suddenly to 36 b. hp. for 10 min. It was re-

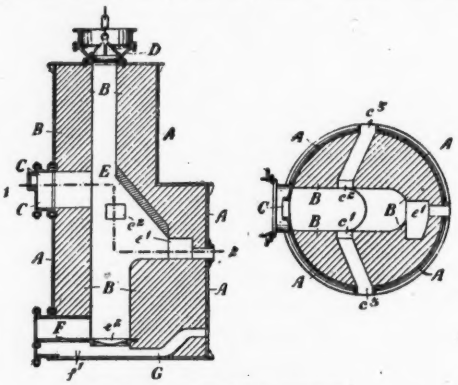


FIG. 3. ORIGINAL DESIGN

ported that there was no perceptible loss of heat in the generator fire after the end of the no-load period and from all appearances the producer could have maintained the engine at work light for a much longer period.

Comparisons

From these particulars it would appear that at last a bituminous fuel suction gas plant has been successfully evolved, and it is interesting to note the differences between the original design as described in the patent specification, and the plant as now made after actual trial and experiment. Fig. 3 is taken from the drawing accompanying the patent specification and shows a cylindrical generator, but the plant as now made is rectangular. It would appear that experience showed the necessity of providing a clearing door for removing ashes from both sides of the fire, while the accumulation of ashes below the grate interfered with the passage of gas through the port G of the original design. But the main improvement is the provision of a reverse sloping wall at the base of the generator.

The patent specification claimed that the upper sloping wall caused the fuel to pack closely against the face, being supported upon the projecting fire brick B, Fig. 3. This does not seem to have given the best results seeing that the latest design encourages the fuel to pack against the lower slope and to fall away from the face of the upper, as before mentioned. These differences, slight in themselves, are of much interest to those who are earnest students of gas producer design.

TO COMPUTE THE HORSEPOWER necessary to raise water any height, multiply the gallons per minute by 8.35. Multiply this product by the feet of lift; the result is foot pounds. Divide by 33,000 to reduce to horsepower per minute. An allowance of 50 per cent should be made for friction, etc.

RATING AN ENGINE

METHOD OF FINDING PROBABLE MEAN EFFECTIVE PRESSURE AND HORSEPOWER FOR SIMPLE AND COMPOUND ENGINES

IN RATING an engine it is, of course, necessary to establish or assume certain conditions under which the engine is to operate and the ones usually given are, the horsepower which it is required to furnish, the number of revolutions at which it shall run, the initial boiler pressure and back pressure, and whether the engine is to be simple or compound.

Rating generally is made at the cutoff which will be most economical for the engine to run at and then, if desired, the maximum load which the engine can carry and possible overload can also be figured and stated, but this is not usually specified or required. Practice has shown that the most economical cutoff is in the region of ¼ and ratings are usually made at either 1/5 or ¼ or ⅓ cutoff, ¼ being the most common. The first step is then to find the probable mean effective pressure, and this may be done either by calculation or by drawing of the theoretical indicator card for the engine and finding the mean effective pressure by the use of a planimeter.

Getting the Mean Effective Pressure.

To get a reasonably good approximation, it is necessary to assume some clearance and this involves knowing the type of engine. For a high-speed automatic with single valve the clearance may be taken as 15 per cent, for medium speed, with 2 or 4 valves at 8 per cent, and for the Corliss or slow-speed 4-valve at 5 per cent unless more accurate values are available. The ratio of expansion will then be found by dividing one plus the clearance expressed as a per cent by the cutoff plus the clearance both expressed as per cents. For instance, where the cutoff is at ¼ stroke and a clearance of 5 per cent, the ratio of expansion will be $(1 + 0.05) \div (0.25 + 0.05) = 3.5$. From a table of hyperbolic logarithms, find the logarithm of the ratio of expansion and add one to it. Then multiply by the initial pressure in pounds absolute and by one plus the clearance and divide by the ratio of expansion. If in this instance we have an initial pressure of 100 lb. gage, we find that the hyperbolic logarithm of 3.5 is 1.2528 and adding one gives 2.2528; multiply this by 115, then by 1.05, and divide by 3.5, gives 77.5. Multiply the initial pressure by the clearance, equals 115×0.05, gives 5.75, and subtract this from the value before found, 77.75, leaves 72 lb. as the mean forward pressure. From this is to be subtracted the back pressure, which we will assume as 16 lb., leaving the mean effective pressure of 56 lb. per square inch.

To avoid the bother of computation, and the use of the table of hyperbolic logarithms, the table given herewith has been worked out and the process would then be as follows: Follow along the column heads labeled cutoff to the desired point ¼ and then down the column to the desired clearance 5 and factor 0.626 is given. Multiply this by the initial pressure, 115, giving 72 lb., which is the mean forward pressure, and subtract the back pressure, 16 lb., giving 56 lb., the mean effective pressure as before.

This value is, however, too high, as losses due to compression, valve action, etc., have not been taken into account, and it is necessary to multiply the pressure just found by another factor whose value depends on the type of valve and the engine speed. For engines working at rated load under good conditions, the following may be used to get approximately correct results for mean effective pressure. For Corliss engine, 0.9; for medium speed engine, 0.87; for high speed engine, 0.7. If the engine is compound and of the same type the factors would be 0.866, 0.83 and 0.68, these lower values in compound engines being due to loss in the receivers, greater back pressure, and other losses between cylinders. $56 \times 0.9 = 50.4$ lb., the corrected mean effective pressure.

If the engine is to be compound, the card is drawn and horsepower is figured exactly the same as if the power were all developed in the low-pressure cylinder and the mean effective pressure is found for the entire range of expansion from initial pressure to condenser pressure, the cutoff being taken at 1/9 or 1/10 stroke.

If the speed of the engine is given, the length of stroke is then chosen which will bring the piston speed within the limits of good practice. For high-speed engines the piston speed runs from 550 to 700 ft. a minute, and for Corliss engines from 300 to 500 ft. a minute. The unknown factor is then the area of the piston, which can be found as follows: $2 \times 33{,}000$ times the horsepower $\div$ (the mean effective pressure $\times$ the length of the stroke $\times$ the revolutions per minute times 2).

Assuming the revolutions per minute as being 82 and the piston speed to be 490 ft. a minute, we have

FIG. I. TABLE OF MEAN FORWARD PRESSURES PER I LB. ABSOLUTE INITIAL PRESSURE

Clearance	Cut off at	1/10 or 0.1	3/28 or 0.105	1/9 or 0.111	3/27 or 0.118	1/8 or 0.125	3/24 or 0.133	1/7 or 0.143	3/22 or 0.154	1/6 or 0.167	1/11 or 0.182	1/5 or 0.2	2/9 or 0.222	1/4 or 0.25	3/10 or 0.3	1/3 or 0.333	3/8 or 0.375	2/5 or 0.4	1/2 or 0.5	3/5 or 0.6	5/8 or 0.625	2/3 or 0.667	7/10 or 0.7	3/4 or 0.75
	0	0.330	0.342	0.355	0.369	0.385	0.402	0.421	0.442	0.465	0.492	0.522	0.556	0.596	0.661	0.699	0.743	0.766	0.846	0.906	0.919	0.937	0.949	0.966
	1	0.344	0.355	0.368	0.382	0.397	0.413	0.432	0.452	0.475	0.501	0.530	0.564	0.603	0.666	0.704	0.747	0.770	0.849	0.909	0.920	0.937	0.949	0.966
	2	0.357	0.367	0.379	0.394	0.408	0.424	0.442	0.462	0.484	0.509	0.538	0.571	0.609	0.671	0.708	0.750	0.773	0.851	0.911	0.921	0.938	0.952	0.964
	3	0.369	0.379	0.391	0.405	0.419	0.434	0.452	0.471	0.493	0.517	0.545	0.577	0.615	0.676	0.712	0.753	0.776	0.853	0.913	0.922	0.940	0.951	0.966
	4	0.381	0.392	0.402	0.416	0.429	0.443	0.461	0.480	0.502	0.525	0.552	0.583	0.621	0.681	0.716	0.756	0.779	0.855	0.914	0.923	0.939	0.954	0.969
	5	0.392	0.402	0.413	0.426	0.439	0.452	0.470	0.489	0.510	0.532	0.559	0.589	0.626	0.685	0.720	0.759	0.782	0.857	0.914	0.925	0.938	0.952	0.966
	6	0.403	0.412	0.423	0.436	0.448	0.461	0.479	0.497	0.517	0.539	0.566	0.595	0.631	0.689	0.724	0.762	0.785	0.859	0.914	0.925	0.941	0.960	0.970
	7	0.413	0.422	0.433	0.445	0.457	0.470	0.487	0.506	0.524	0.546	0.572	0.601	0.636	0.693	0.728	0.765	0.787	0.861	0.915	0.925	0.941	0.953	0.966
	8	0.423	0.431	0.442	0.454	0.466	0.478	0.495	0.512	0.531	0.553	0.578	0.607	0.641	0.697	0.731	0.768	0.789	0.862	0.915	0.926	0.944	0.951	0.969
	9	0.432	0.440	0.451	0.463	0.474	0.486	0.503	0.519	0.538	0.560	0.584	0.613	0.646	0.701	0.734	0.770	0.791	0.863	0.916	0.924	0.943	0.954	0.970
	10	0.441	0.449	0.460	0.471	0.482	0.494	0.510	0.526	0.545	0.566	0.590	0.618	0.651	0.704	0.737	0.772	0.793	0.864	0.916	0.929	0.941	0 957	0.966
	11	0.450	0.458	0.469	0.479	0.490	0.502	0.517	0.533	0.552	0.572	0.595	0.623	0.655	0.707	0.740	0.774	0.795	0.865	0.917	0.929	0.946	0.955	0.969
	12	0.458	0.466	0.476	0.487	0.497	0.509	0.524	0.540	0.559	0 578	0.600	0 627	0.659	0.710	0.743	0.776	0.797	0.866	0.920	0.927	0.943	0.958	0.971
	13	0.466	0.474	0.483	0.494	0.504	0.516	0.531	0.547	0.565	0.584	0.605	0 631	0.663	0.713	0.746	3.778	0.799	0.867	0.920	0.931	0.946	0.955	0.967
	14	0.474	0.482	0.490	0.501	0.511	0.523	0.538	0.553	0.570	0.589	0.610	0.635	0.667	0.716	0.749	0.780	0 801	0.868	0 921	0.930	0.944	0.957	0.970
	15	0.482	0.489	0.497	0.508	0.518	0.529	0.544	0 559	0.574	0.594	0.615	0.639	0.671	0.719	0.752	0.781	0 803	0.869	0.919	0.929	0.947	0.955	0.972

490 ÷ 82 = about 6 ft. and the distance traveled by the piston in a revolution or 0.5, this equals 3 ft. to the stroke. If the engine is to be 130 hp. we shall then have from the regular formula for the horsepower of an engine that the area of the piston equals 33,000 × 130 ÷ (50.4 × 3 × 82 × 2) = 173 sq. in., which from a table of areas of circles is found to be about 15 in. in diameter circle.

Mean Effective Pressure from Theoretical Diagram

To use this method calls for the laying out of the theoretical diagram, the method for which is as follows: We will take in this case a compound engine running at rated capacity with initial pressure of 125 lb. gage, back pressure 2 lb. gage, a speed of 112 r. p. m. and a ratio of cylinder volumes of 4, that is, the low-pressure cylinder is to be 4 times the volume of the high-pressure. This will come into the medium speed class and will give as a clearance value 8 per cent.

Begin by drawing a horizontal line A B for the absolute pressure line and erect a vertical A C at the left hand end. We will use a scale of 30 lb. to the inch for the pressure measured vertically and a card 3.5 in. long. To the left of the card lay off 8 per cent of the high pressure cylinder volume, equals $0.08 \times \frac{3.5}{4}$ = 0.07 in. for the clearance and draw another vertical line D E. We now have the horizontal A B and the verticals A C and D E on the diagram, Fig. 2.

As the initial pressure is 125 + 15 = 140 lb. absolute, we lay off 140 ÷ 30 = 4.67 in. on the line A C, and this gives us the height of the card above the zero pressure line at C. At this height, draw a horizontal line which will be the steam line of the theoretical card. Three-eighths cutoff will be ⅓ in. from the beginning of the card or at 0.4 in. from the zero volume line D E. This locates the point of the cutoff F and to draw the expansion curve we drop a vertical line from F, and continue the horizontal line C F to G. The line F G is then divided at the various points H J K L M, and from H a line is laid off H D, and intersection N with the line F S is marked. From H drop a vertical and from N draw a horizontal and the point of intersection of these 2 is a point on the theoretical curve. Likewise from J trace the line J D, and find the intersection O with the line F S; then draw horizontal from O and a vertical from J and the intersection gives another point on the curve. In this way continue until sufficient points are located so that the curve can be drawn.

The terminal pressure is at the point P and the line U X indicating the compression is drawn by a similar process. We then lay off the distance B W equal to 17 ÷ 30 = 0.57 in. to represent the back pressure 17 lb. absolute and draw the line W U giving the entire outline of the theoretical card C F P W U X.

The mean effective pressure can be determined from this card, either by the use of a planimeter or by dividing the card into 10 equal parts and measuring the distance from the forward pressure line to the back pressure line at the middle of each division. To obtain the location of these middle lines, take some scale which is divided into 10 parts and lay it at an angle, so that the first and 20th division come on the lines C X and P B, respectively. Then shift it over ½ a division and mark the middle ordinate point as indicated by the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 on the diagram. The vertical lines are then drawn through these points and the distances from top to bottom line on the card measured and added together and divided by 10 to give the average ordinate. These measurements are taken with a 30-lb. scale which gives the pound reading direct, 125, 73, 40, 26, 17, 11, 7, 5, 1.5, 0.5. Sum of these is 306 lb. and 0.1 this is 30.6 lb., the mean effective pressure. 30.6 × 0.83 = 25.4 lb., the corrected mean effective pressure for this class of engine.

Assume that the piston speed for this medium speed engine is to be chosen as 560 ft. a minute, then 560 ÷ 112, the revolutions per minute, gives 5 ft. as the piston travel per revolution, or 2.5 ft. as the stroke. If an engine of 200 hp. is desired, the method for determining the cylinder diameter is the same as in the

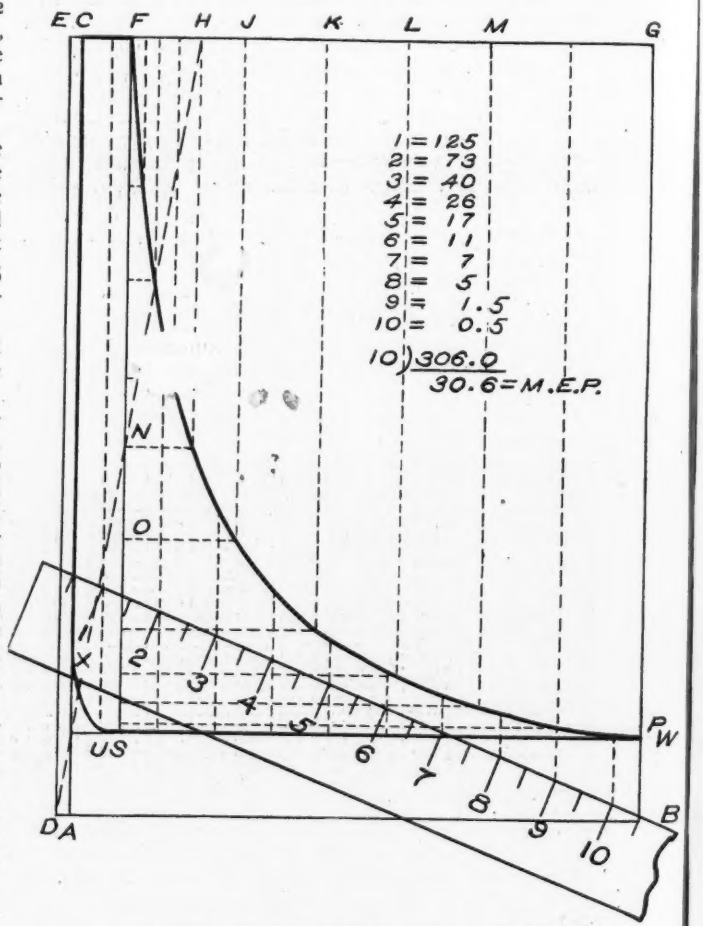


FIG. 2. CONSTRUCTING THEORETICAL CARD AND FINDING MEAN EFFECTIVE PRESSURE

previous case, viz., 200 × 33,000 ÷ (112 × 2 × 2.5 × 25.4) = 452.5 sq. in. as the piston area, which, from a table of circles, gives a diameter of 24 in. as near as can be obtained.

As the cylinder volume ratio is 4, the ratio of diameters will be the square root of 4 or 2, and the high-pressure cylinder will be then 12 in. in diameter.

The point left to determine is the receiver pressure. which should be so chosen as to divide the horsepower equally between the 2 cylinders. The method of determining this is fully explained on page 61 of the issue of Practical Engineer for Nov., 1908.

THERE IS NO SUBSTITUTE for thorough-going, ardent and sincere earnestness.—Dickens.

TERRY STEAM TURBINE

THE designer of the Terry steam turbine had in mind 2 essential features; to produce first, an efficient, small, low speed engine and secondly one of the simplest designs. This turbine is of the compound velocity stage impulse type, that is, the steam is practically wholly expanded in a correctly formed jet or nozzle, wherein its static pressure is converted into velocity energy.

It will be seen by inspecting Fig. 1 that the wheel is fitted with semi-circular buckets, which are struck by the steam escaping from the jet. Upon striking the bucket the steam is reversed in direction, leaving at the opposite side, and then enters the first stationary bucket or reversing chamber. This chamber redirects the steam back into another bucket of the same wheel at a point adjacent to the jet. This operation is repeated as many times as is necessary for the

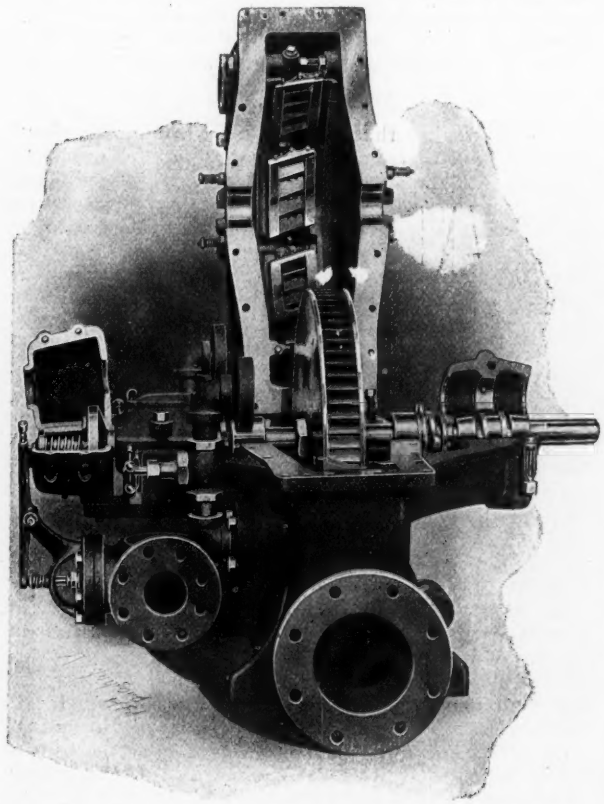


FIG. 1. TERRY STEAM TURBINE OPENED

complete utilization of all the available energy in the steam, its velocity being converted into energy consecutively at each reversal of steam.

As the direction of the flow of the steam is at all times normal to the shaft, there is no end thrust regardless of the initial pressure or vacuum maintained. Increased power for a wheel of a given diameter is obtained by fitting additional jets and reversing chambers in the casing, each jet, of course, being supplied with live steam. When it is wished to carry only a partial load, it is a simple matter to turn off one or more of the jets, and thus maintain the efficiency of full load. As the steam is fully expanded in the nozzle, the turbine casing and wheel are not subjected to high pressures or superheat, which fact tends to improve the efficiency.

The wheel and shaft are of steel, perfectly balanced and tested safely to withstand a speed of 50 per cent above rating. The stuffing boxes in the turbine cases are of special construction, with ground metal seats, allowing free movement of the shaft while maintaining a perfectly tight joint without the use of soft packing.

Ring lubrication is employed for the main bearings, which are supported by brackets from the turbine casing. In the smaller sizes they are made in 1 piece of high grade phosphor bronze, while in the larger sizes they are of high grade babbitt metal.

A fly-ball type governor is employed which is mounted directly on the turbine shaft and controls a specially constructed miter throttle valve. Should the main governor spring break, the governor valve

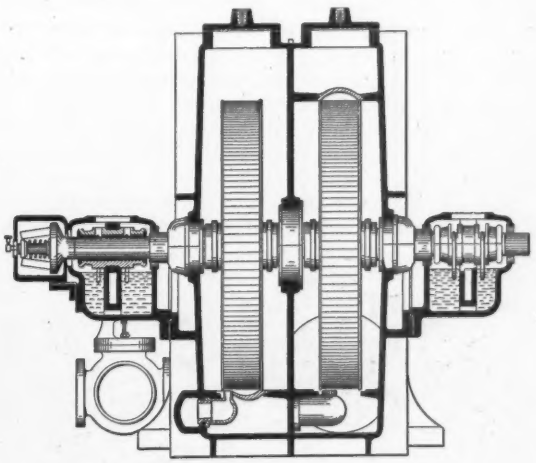


FIG. 2. CONDENSING TERRY TURBINE

would close immediately. With this form of governor a maximum speed variation of 2 per cent is guaranteed by the manufacturers.

In Fig. 2 will be seen the form of turbine which is used for condensing service. It is merely a 2-stage turbine in all except the smaller sizes, where the

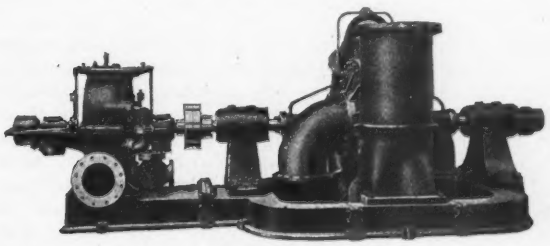


FIG. 3. TERRY TURBINE CONNECTED TO CENTRIFUGAL PUMP

single stage is employed. After the steam is passed through the high pressure stage, it enters the second stage and passes through nozzles and reversing chambers arranged similarly to those in the first stage.

This type of turbine is well adapted for use with exhaust steam from non-condensing engines. As the energy in steam expanded from atmospheric pressure to 28 in. is almost equal to that in the same steam expanded from 150 lb. to atmosphere, the saving in

fuel resulting from using this exhaust steam by means of a turbine with a condenser for low pressure vacuum is apparent.

The Terry steam turbine has proved admirably successful in direct connected generating sets up to and including 300 kw., the low speed eliminating commutating troubles usually found in direct current turbine generators. The speed of these generators varies from 4,000 r. p. m. for the 5-kw. to 1,250 r. p. m. for the 300-kw. generator.

In Fig. 3 will be seen how the Terry turbine can be employed for driving a centrifugal pump which is directly connected to it. In the same manner, this type of engine may be direct connected to blowers or fans for mechanical draft. The comparatively low speed employed permits it to be belted to a line shaft, or where the reduction of speed is too great, a counter shaft is used.

This turbine is the product of the Terry Steam Turbine Co. of Hartford, Conn.

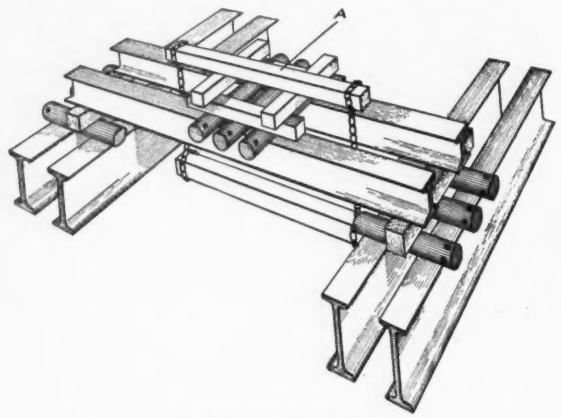
REMINISCENCES OF AN ERECTING ENGINEER—II

PREPARATORY WORK

By M. E. P.

THE work of getting the heavier parts of an engine into the engine room and placed, calls for experience, skill and the exercise of good judgment in dealing with the conditions as they are found. No 2 plants are alike and no rule can be given for the handling of work that will fit all cases, but there are some that can always be applied. To make these principles plain, suppose that we do as the lawyers do — take a "hypothetical case."

Suppose we have an engine, 30 by 60 by 48 in. vertical, cross-compound, direct connected to an electric



TEMPORARY CRANE RIG

generator and this engine is to be installed in an engine room which is one story above the ground. The plant is an old one and has several boilers and engines in service. The boilers, pumps, condensers and much of the exhaust and water piping are all below the level of the engine room floor. There is no crane in the plant and conditions are such that the parts of the new engine must be delivered on the ground by the side of the boiler room and taken through it and then raised to the required height by some means which we shall have to design and furnish. Take all these premises to be true, how would you do the work of erecting?

Here we have our problem and we must solve it so as to accomplish the work with as little cost as possible and in the quickest time. We shall have first to decide where the parts of the engine are to be gotten into the engine room. Usually, this will be perfectly clear at once, but sometimes it may take quite a little study to find a place where an opening large enough to pass the largest pieces can be found. The machinery and piping already in place may interfere so that some temporary change will have to be made for our convenience. When the place is decided on, the first thing is to plan the hoisting arrangements and the runway from outside the building to the point where the parts are to be raised to the engine room floor.

Temporary Crane

Remembering that there is no crane in the plant, we shall have to decide how we are to do the necessary hoisting. As the engine is a vertical one, the cylinders and receiver and their parts will have to be raised to a considerable height and some means will have to be devised to do it. The conventional shear pole can be used but is inconvenient in many respects and can be improved on by erecting a temporary crane which may be made something like the sketch herewith.

A is the piece from which the chain hoist is hung. Instead of hanging it directly from this piece, I used two heavy chains, one at each end of A, forming a loop which hung low enough so that a timber of the same size as that marked A hung parallel and low enough to just clear the rollers. The chains were firmly secured to the timbers so that they could not slip off the ends and the chain hoists were secured to the lower timber. In this particular case, I used 2 10-ton hoists and it will be found a convenience to use 2 hoists rather than 1 as pieces can readily be leveled and swung about by their aid. The pieces that the hoists are hung from must be long enough so that the chains will not interfere with the rollers as they are put in place or taken out. The sketch is crude and is only intended to suggest the construction which will have to be modified to suit the conditions. The ends of the rollers are bored so that a bar can be used to turn them when it is wished to move in either direction. The crane will of course be built so that it will reach from the opening through which the parts come to any part of the engine and will be as high as possible to give plenty of head room when hoisting.

The erecting man will be wise to make a drawing of his crane and get out a bill of material and figure the cost of constructing it and then figure the probable saving of time that it will make so as to see if he will be justified in going to the expense. If the walls of the building are not strong enough to carry the load that would be put upon them, he will have to build his crane entirely or partially independent of them and this will be sure to make the expense rather large. Nevertheless, a thorough study of the conditions and the work to be done on an engine as large as the one we have in hand will usually decide one that the saving in time over any other method will justify the expense. Blocking and lifting by means of jacks is a

slow method and much more expensive than one realizes unless he stops to figure it all out. In our case we will decide on the crane and have it built.

Runway and Blocking

Our crane having been disposed of, the next thing is to get a runway through the boiler room to the opening through which we are to lift the parts. In future, I will call this opening the door. The boiler room floor may be made of cast iron plates and when we take them up we may find that there is a perfect tangle of piping in the way so that it will be difficult to get any blocking on to a solid footing without resting on some of the pipes, but we have got to find some way to do so, as it will not be safe to rest on the pipes; the danger of breaking them is too great. What space there is will be filled carefully with as large blocking as possible and as soon as we are above the tops of the pipes, heavy blocks are used and made as firm as possible. The blocking is built up cob-house fashion and so arranged that the pieces that come next the runway timbers are at right angles to them.

Never lay timbers that are to carry a heavy load on blocks laid with the grain running in the same direction. This rule should always be carefully followed as many an accident is due to the breaking of it. It is the hardest thing to get the help, that is usually availble on such work, to be sufficiently careful in blocking up work. I have always found it necessary to stand right over them and select each block and timber and tell them exactly where to place it and then see that it is solid. If a block has rounding corners, they will be sure to put it down with the corners in the worst possible position.

If the runway is to be built with any considerable incline, the ends of the run timbers will have to be securely anchored so that they cannot slide when under the load. In any case, be sure that the whole structure is solid. It will pay to build it very securely at first as all of the heavy parts will have to pass over it so that the job had best be done once for all while we are about it. When we have given the crane and runway a final, critical inspection, we are ready to commence getting in the engine parts.

Handling the Base

The first thing we shall want is the base which goes on the side of the foundation furthest from the door. Suppose it to be the low-pressure side of the engine. The base will not be on skids and as it is hollow, we may find it necessary to put some under it for convenience in handling it. While this is being done, we can square it around to the runway and get it into such a position that it is ready to start into the building. We shall want some good rollers, a long 4-fold tackle and a lighter one that a sailor would call a watch tackle, some jacks, at least 2 crow-bars and a heavy sledge.

We now want to get rollers under the base and the tackle hooked on. Now right here is a chance to work a little trick that will show the people at the plant where you are that you know what you are about. They will probably be watching you when you make your first moves toward getting your stuff into the engine room. Naturally, you want to have them think that you know your business and on this first piece you have the chance to show them that you know how to make every move count. Lift the end of the base next the run high enough to put a roller under it and about 1/3 of the way back. Hook on the tackle so that the hauling part will lead towards the base and have the hook as high as possible on the base. Overhaul the tackle and hook the other block as near the level of the runway as possible. When you take a strain on the tackle the force will be exerted in such a way that the base will tend to tip towards the run and with a little help from the crow-bars under the low end, it will start forward and soon tip towards the tackle. This is exactly what we want it to do. Have a roller on top of the runway timbers so placed that the skids will just catch on it as they come down and you have your base on 2 rollers.

When the base is safely on the 2 rollers, keep on with the hauling, placing new rollers as they are needed and guiding the base by cutting the rollers in the familiar way. Watch the runway constantly while this first piece is being hauled in and strengthen any parts that seem to be weak. When the base is under the door, it will have to be slung and the chain falls hooked on in such a way as to keep it practically level and then it can be hoisted into the engine room and carried over the foundation bolts.

Before it is lowered into place, provision should be made for leveling it and the waste or other material used around the foundation bolts in their tubes should be removed. The nuts must be taken off and the foundation swept clean. Some builders make provision for leveling by putting leveling screws into the base, and these are a great convenience, but if there are none iron wedges must be provided as well as some flat iron plates to lay on the foundation. The plates will also be wanted to put under the screws if they are provided.

When all is ready, lower the base carefully over the foundation bolts and see that they all enter freely and does not bind on the threads. It is a great nuisance to have to file out the threads if they get jammed in placing the base. The high pressure base will be handled in the same way as the one we have just placed and then the back columns will have to be gotten in. They will be lying down and will have to be upended and the best place to do this will be when we hook on the crane to lift them into the engine room.

There is a point to be looked after in placing the back columns that will apply to all parts that are to be bolted together. Be sure that the adjoining surfaces are clean and free from burrs and bruises. Take a file and go over all edges and see that they are smooth and brush off all the lint and dust. Have some one take a heavy block and rap the back column well so as to dislodge all dirt that might fall while lowering in place and then pass the palm of the hand over the finished surface to remove the last trace of dust. Don't use waste in cleaning parts as it leaves too much lint. It is better and cheaper to buy some old rags as they can be washed out in the kerosene that is used for the cleaning of parts.

When the back columns are in place, we have the choice of either of 2 ways of lining the bases. We can work from the main bearings and guides or we can put the shaft in place and line from that. The latter is the more accurate way but means more work than the other as the shaft will have to come out and be placed out of the way while some of the other work is being done. It is possible to put the lower halves of the generator and wheel into the pit and then put in the shaft and leave it in place but this method has certain disadvantages so that I almost always take the shaft out after lining the engine and put other parts in place before the shaft is finally put in.

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THE LOW-PRESSURE TURBINE

In the development of the steam turbine the first tendency was naturally, as in the case of any new invention, to try to make it do anything which any type of steam engine had ever done. The compactness of the unit and its simplicity of construction made it seem an ideal equipment for all kinds and conditions of plants.

While it was well known that one great advantage lay in its ability to use the last ounce of energy in expanding steam down to extremely low pressures, it was not so well recognized that at the higher pressures the friction of runners through the steam and the disadvantages which come with any extremely high-speed machinery might make it no more desirable than reciprocating engines, for conditions where high-pressure steam only was to be used. On the other hand at extremely low pressures the reciprocating engine cannot be put to use to advantage because of the great size required in the cylinder, and here the turbine alone is available.

With the realization that the reciprocating engine has advantages which cannot be gainsaid, the turbine advocates have come to the realization that a combination of the 2 may frequently be of greater advantage than either machine standing by itself. This has brought about the special low-pressure steam turbine, which is now recognized as standard good engineering under particular conditions, the turbine taking the steam from the exhaust of a reciprocating engine and expanding it down to the greatest obtainable vacuum. Like all other engineering problems, the planning of such a combination needs good judgment and careful consideration of the conditions in each case. The different typical cases which may arise are considered by Mr. Willard in the article which heads this issue, and a sequel which will appear in December, and we would commend these articles, therefore, to the considerations of our readers.

RATING ENGINES

What load will my engine carry.? is a question which often arises when an extension of a plant is planned. Evidently the maximum load that an engine can carry is when it takes steam at boiler pressure throughout the entire stroke, but nobody in this enlightened day is going to run an engine under any such conditions except perhaps for a few minutes at a time, if he can possibly avoid it. The question comes then, what load ought my engine to carry?

Makers, usually in stating engine capacities give several different horsepowers, depending on the boiler pressure and the point of cutoff, but what the engine will do in other conditions than these stated is not given. For best results, of course, an engine ought to be run at the load which gives it the least steam consumption per horsepower-hour. By experiment it has been determined that this usually comes with cutoff at between 1/5 and 1/3 stroke, and single cylinder en-

gines are most commonly rated at the power they will give at ¼ stroke.

The pressure to be carried depends upon the boiler plant as well as the engine, and the conditions of steam pressure in the plant may not be those for which the engine was built, or at which the maker states its capacity. Also, in reorganizing a plant or in planning any changes such as increasing steam pressure to keep up with modern practice and installing new boilers, or decreasing steam pressure to correspond with the increased age of boilers, the engineer must rerate his engine for the new conditions.

This he can do by the method shown on page 655 of this issue; it is one which can easily be carried out and gives results corresponding to those of the foremost engine builders. Care should be taken, however, to make all the allowances specified for clearance, for the rounding of diagram corners and, if horsepower delivered from the engine is required, allowance must be made for the engine friction.

If an engine is to be used to drive a generator, a calculation should also be made to insure that the engine at the longest cutoff which it can make is capable of driving the generator at the greatest overload capacity which it will carry safely; otherwise in the growth of the plant, or in an emergency the engine may fail to give the best service of which the plant as a whole is capable.

BOOSTERS

A Booster is a thing which boosts. In this particular instance it boosts voltage on an electric circuit, and the how of it, and the why of it are things which many of us do not fully understand. The article by Mr. McNeill in this issue will serve to clear something of this cloudiness, and to show one of the things which may cause sorrow to the engineer in charge of a booster unit. There are many other things which may play havoc with the peace of mind of a chief who has a booster substation to take care of, and we would be glad to have some of our readers who are handling this class of machinery tell further about their experiences with boosters that won't boost, or synchronize, and that insist on pumping.

ERECTING MACHINERY

When installing machinery in a plant, half the battle lies in getting ready beforehand and the other half in being careful. Horse sense is the great essential, without which all other things are as nothing. Trying to handle a 10-ton casting with a crowbar and a piece of 2-in. pipe as a roller is a hopeless task. Any fellow who tried that would deserve what he probably would get, a blue ticket on pay day. But some things just as foolish as that have been done in the course of erecting power plants.

Good sense will help out in overcoming a difficulty after it has arisen, but experience tells how to avoid, and how to keep out of the difficulty. There are troubles enough which cannot be foreseen, therefore getting the experience of one who has spent years on erection work, where it can be drawn on to avoid the probable sources of hindrance and irritation, is of the greatest help.

The articles now running by M. E. P. on this subject are worth preserving by anybody who ever expects to have to erect or install any apparatus which cannot be lugged around in one's arms. The text of the installment in this issue will bear out the statement made in the beginning that success in installation work depends first on being thoroughly prepared beforehand, and second on being careful.

PLANNING BIG

Reserve capacity in a plant is absolutely necessary if it is at all important that the machinery be kept in constant operation. Allowance for growth must also be made unless conditions are such that no growth can occur; hence it is always said, "Get the apparatus big enough; it costs but little more and will save heavy future outlay in alterations. Besides big machines are more efficient than small ones."

The last clause is the misleading one. True a big machine run at full load is more efficient than a small one at full load, but a big machine at 0.5 or even 0.75 load is not so efficient as a small one at full load. It takes more room, costs more to buy, to house, to repair, to replace, to run. In fact is an extra expense in all ways.

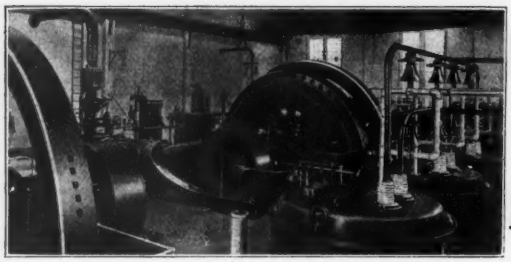
Unless it is certain that the bigger machine can be run for a considerable part of the time at once or soon at above 0.75 load, it is better to choose a smaller machine and run it overloaded when necessary, even at the expense of adding another machine later as the load grows.

As an instance, on a recent test of motors in a railroad repair plant, the motors were found working under an average load of 0.3 rated capacity, with average efficiency of 79 per cent, whereas if the average load could have been at 0.5 the rated efficiency would have risen to 86 per cent and the power factor raised from 0.6 to 0.8 allowing the generator to carry a much larger load. Individual tests of motors showed the capacity to be from 0.25 high to 2.5 times high. This is, perhaps, an exceptional case; but not so much so as to be uncommon.

It's nice to have the comfortable feeling of "plenty of power to drive things," but subdivision to keep all units in operation always well loaded pays quite as well as does generous provision of power actually needed.

IN MACHINERY, E. W. NORTON gives the following method for finishing bronze: Mix 1 part of muriatic acid and 2 parts of water and apply the diluted acid to the bronze article with a cloth. Before applying this acid cleanse the article thoroughly from all grease, and after having applied the acid, let the article dry and then polish with sweet oil.

ELECTRICAL



MACHINERY AND APPARATUS

EXPERIENCE WITH BOOSTERS

By Fred McNeill

A SERIOUS accident that happened to a booster set the other day in which the motor was accidently disconnected from the line, causing the set to run away and wreck itself, calls to the mind of the writer the great difficulty he experienced when new at the electrical business in learning what a booster was and how it accomplished the work it was intended for.

The only available source of information on the subject at that time was the electrical periodicals, as the booster was also new at the business; but the booster is comparatively old now, and writers usually assume that their readers know all about how it works and confine themselves to some new or special feature on the subject, that is interesting to them and the

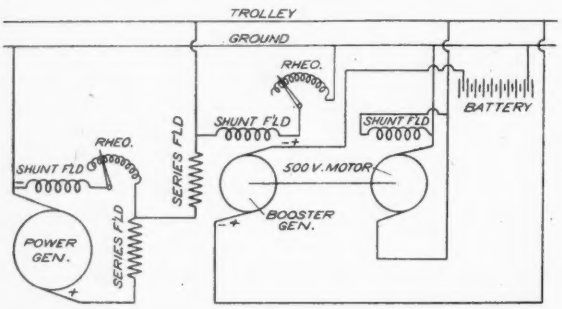


FIG. 1. CONNECTIONS FOR A DIFFERENTIAL BOOSTER SET

expert electrical engineer, and the result is that the reader who happens to be unfamiliar with the subject, but who is looking for information along those lines, selects the article by its heading, and is usually left more in the dark than he was before reading it.

What Is a Booster?

A booster is, as its name implies, a generator, designed and built for the purpose of boosting or raising the voltage of another generator, or the voltage of a long circuit where the cost of the power lost due to the resistance of the wire is greater than the cost of a booster and where the cost of the booster set installed is less than the cost of the additional copper that would be required to give the same effect.

If a current is to be conveyed a long distance, say 8 or 10 miles, the reader readily will understand that it would be poor economy indeed to install copper wire large enough so that there would be no drop, or loss of voltage, and if it is desired to have 500 or 600 volts at the end of the line, it would be hardly practical to raise the generator voltage high enough to supply the loss, on account of the excess voltage that would necessarily be delivered to the motors near the generator, and the fact that the variations due to changes of load, would be detrimental to good operation.

A generator for that purpose, would have to be adjusted at no load for the voltage that was required at the end of the line, and at full load for the no load voltage, plus the drop in the line. Now, if the no load voltage was say 600 and the drop 150 volts, the generator would have to supply 750 volts at full load, and as the load varied, the voltage would fluctuate between 600 and 750 volts, no matter whether the current was being drawn off right at the generator, or at the extreme end of the line. In cases of this kind, the booster is required; it may be connected in series with the line at any point and will maintain an even pressure beyond that point, so long as the generator delivers an even pressure to it.

Kinds of Windings

A booster may be a plain series generator, that is, without a shunt winding, where all of the line current passes through the field and armature, the field and armature being in series with each other, or it may be a cumulative compound generator that is having both series and shunt winding so arranged that increasing the current in either the shunt or series winding, tends to increase the armature voltage.

The shunt windings of such machines are usually supplied with current from the line instead of from their own armatures, as is the case with an ordinary cumulative compound generator.

The booster that met with the accident was of the differential type, that is, it had both series and shunt winding, which were so connected that they were in opposition to each other.

For the benefit of readers who do not understand thoroughly the differential wound machine, it might be well to say that any compound generator can be converted into a differential machine by simply reversing or interchanging the armature and line wires that are connected to the series terminals, which causes the current flowing out of the armature to flow around the series in the opposite direction. The magnetizing effect of the series is then opposite to that of the shunt winding.

A shunt coil having 1,000 turns of wire around it,

through which 1 ampere of current is flowing, is said to have 1,000 ampere turns, or if 2 amperes were flowing, it would have 2,000 ampere turns; the turns times the amperes, equal ampere turns. Therefore, a field coil that has but one turn of wire, but has a current of 1,000 amperes flowing through it, has 1,000 ampere turns, just the same. Now, if both of these coils, the one having 1,000 turns and the one having only 1 turn, were wound around the same iron core, but in opposite directions, and a current of 1,000 amperes were passed over the latter, and 1 ampere over the former, the result would be zero; the iron would not be magnetized, but if the current in either of the coils be reversed, the result will be the effect of 2,000 ampere turns.

Differential Winding Action

Imagine the above conditions existing in a generator; it will be obvious that no voltage would be generated by an armature turning in a field in which the series and shunt coils were opposing each other; it will also readily be seen that if no current were flowing in the series coil a voltage would be generated in the armature in proportion to the strength of the shunt coils, and that the series coil could not only completely kill that voltage, but if sufficient current were passed over it, would build up a voltage in the opposite direction. In other words, if the shunt coils had 1,000 turns at 1 ampere, and the series had 1 turn at 2,000 amperes, a voltage would be generated, due to the 1,000 extra ampere turns of the series coil. The differential booster depends upon this principle for its operation. When connected, as shown by the accompanying sketch, Fig. 1, and used in connection with storage batteries, can be adjusted automatically to charge and discharge the batteries depending on the load on the line, or the amount of current passing through the series coils, which amounts to the same thing.

The main object of an installation of this kind is, in addition to maintaining an even voltage on the line at variable loads, to maintain an even load on the plant supplying power to the circuit to which it is connected.

The reader no doubt appreciates the fact that a steam plant runs most economically when pulling a steady, even load at or about its rated capacity.

In many cases, and in street railway work especially, it is not possible to regulate the load.

Booster with Storage Batteries

The object of the storage batteries is to distribute the load evenly throughout the whole time the plant is in operation, and this is accomplished by charging the batteries when the plant would otherwise be under loaded and by discharging them when the plant is loaded to, or beyond, its capacity. In this manner, the heavy or peak load as it is called, of the rush hours, is taken off the plant by the batteries, and distributed to it throughout the run, when it can best be taken care of, and in case of accident to the plant where ample battery capacity has been provided, the entire load may be carried by it for a short time, no switch manipulation being necessary; simply shut down the plant and the booster and batteries adjust themselves to the condition.

Figure 1 shows the connections of a differential booster set in connection with storage batteries for street railway work. All apparatus not absolutely necessary for the proper understanding of the scheme, such as switches, circuit breakers and starting apparatus for the motor, has been purposely left out, as they would only make additional wiring necessary, and make the sketch confusing and hard to trace.

The main generator is shown connected, 1 side to the ground and the other side passing through the series winding of the booster to the trolley feeder, and the booster which is being driven by a 500-volt motor is connected in series with the batteries to the trolley feeders, and is excited from the trolley circuit.

Note that both sides of the booster armature are marked neutral. Now imagine that no power is being used on the trolley line and that only the current flowing into the batteries is passing through the series winding of the booster. When this condition prevails, the shunt current is adjusted so that the polarity of the booster is such that it adds to the trolley voltage, that is, the trolley being positive is connected to the negative side of the booster and a full charging current flows to the batteries. Should a load be thrown on the

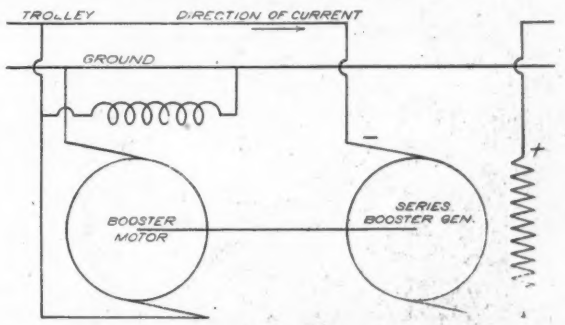


FIG. 2. SERIES BOOSTER SET CONNECTIONS

trolley circuit, the additional current passing over the series winding of the booster reduces the voltage generated by the armature, causing less current to flow into the batteries, and as the load increases on the line less current flows into the batteries until finally no voltage is generated by the booster armature, showing that the strength of the shunt and series winding are equal, and as the voltage of the batteries and generator are then equal no current flows in or out of the batteries, but as the line load is further increased during rush hours, the current flowing through the series winding of the booster not only completely kills the effect of the shunt, but reverses the polarity and builds up a voltage in the opposite direction. This voltage is added to the batteries instead of the line, as in the first instance, which causes the batteries to have a higher potential of course and current to flow from them to the line.

The accident referred to was a booster set of this type. A circuit breaker connected in the motor circuit came out, either on account of overload or some mechanical fault, and the result was the booster deprived of its driving power, not only came to a stand, but reversed, owing to the condition or relation of the battery to the line voltage at that time, and accelerated in speed until both armatures were totally wrecked.

It will readily be understood that the strength of the field would have little or nothing to do with the speed in a case of this kind. A very heavy current was passed through the booster armature, which was doing no work and the speed had to increase until the power flowing through the armature was dissipated in turning it.

A circuit breaker in circuit with the booster would be of no avail in a case of this kind, as little current would be required to flow through the armature under running conditions, would be more than enough

to wreck the machine, should the motor lose its power from any cause whatever.

Arrangements should be made to cut the booster out of circuit automatically whenever current ceases to flow to the motor.

Figure 2 shows the connections of a series booster on a circuit without storage batteries, being intended only to compensate for the drop in the line.

It will readily be seen that this type would also meet with disaster should the motor circuit be broken.

A SINGLE-PHASE MOTOR

The use of alternating-current motors is becoming more and more common as the transmission of power

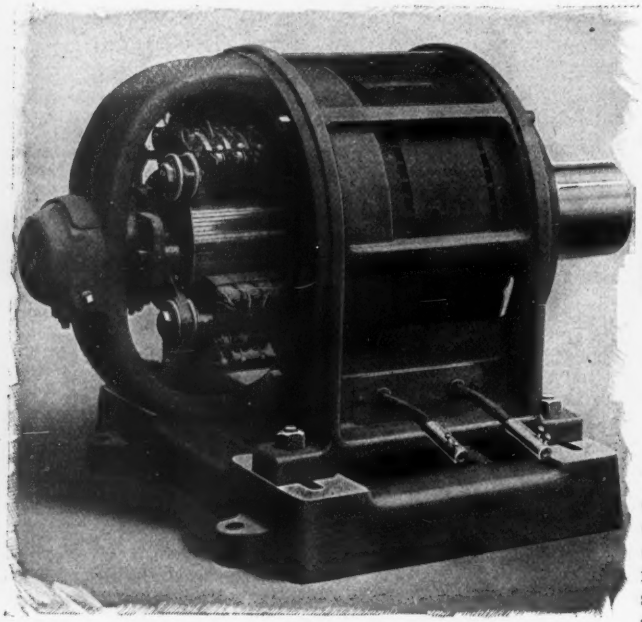
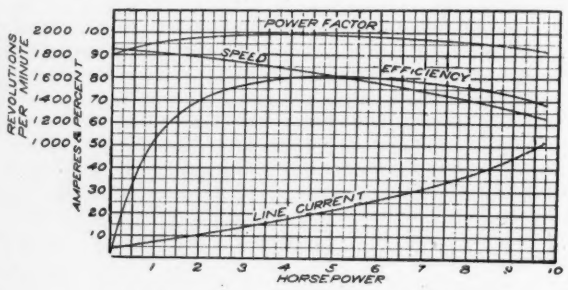


FIG. 1. THE GENERAL ELECTRIC SINGLE-PHASE MOTOR, TYPE RI

from hydraulic plants increases, and for small powers, the cost of the multiphase motor is making the single-phase a desirable piece of apparatus.

The General Electric Co. is bringing out a new type of the singe-phase motor, this being of the kind which starts as a series repulsion motor, by the use of a commutator, and then throws the brushes off the commutator at speed and is run as a single-phase. The line runs in sizes from 0.5 to 5 hp. and is arranged as shown in Fig. 1. It is built to run on current at 110 or 220 volts as desired, at a speed of 1,800 r. p. m. and can have the speed varied from the normal 50 per cent. The starting torque is 300 to 400 per cent of the running torque, thus giving it a powerful pull when starting up a heavy load. As seen from Fig. 1 and from the disassembled view, Fig. 2, these motors are of the skeleton frame form, having the laminations of the stationary part or stator core clamped between cast-iron flanges, to which the end heads are secured. The stator wiring is made up of single-phase windings, each coil being heavily insulated and separated. Leads are brought out to the removable terminal board and are plainly tagged for connection to 110 or 220 volts.

The armature or rotor is of the series drum wound type, and is connected to a commutator which carries 2 sets of brushes, these sets being 90 electrical degrees apart. One set known as the energy brushes is permanently short circuited and stands at an angle to the line of primary magnetism as for the usual repulsion motor connection. The second set is known as compensating brushes, and is connected to a small part



PERFORMANCE OF A 7-HP. MOTOR

of the primary winding included in the control circuit, so that there is impressed upon the armature an electromotive force which serves to raise the power factor and also to keep approximately, synchronous, speed at all loads. Large oil reservoirs and ring oilers of ample size assure good lubrication.

The characteristics of this motor show that the current taken is almost directly in proportion to the load, that the speed drops slowly and that the power factor is maintained at a high value between very light load and considerable overload.

Speed variation is accomplished by the use of controllers, and the speed can be reduced 50 per cent below synchronous speed, by inserting resistance or reactance in series with the energy and compensating brushes. Reversal can be secured by means of special motors, which have a special winding, having terminals for connection with a 4-pole double-throw switch.

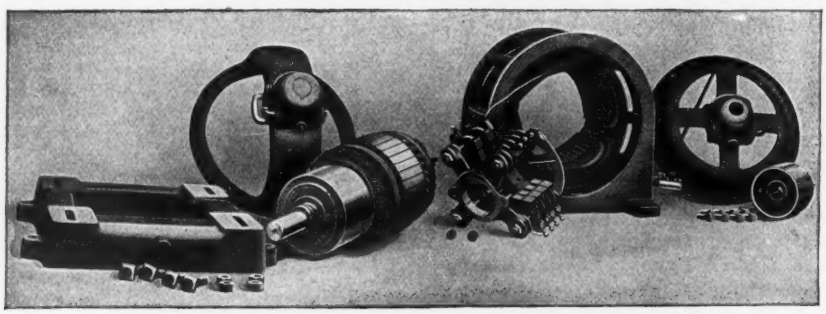


FIG. 2. DISASSEMBLED VIEW OF SINGLE-PHASE MOTOR

A TRANSFORMER DESIGN

IT sometimes becomes necessary for an engineer to rewind a burned-out transformer or he may wish to change the coils in order to get a different ratio of transformation. In order that he may do either of these with an assurance that the transformer will do its work properly it is necessary that he understand the features of transformer design and the relative importance of each element entering into it.

To understand thoroughly any machine or apparatus which is based upon laws of physics it is always advisable to go back to first principles and work up to the final results step by step.

Generation of E. M. F.

One learns in the study of a dynamo that the voltage developed in a coil is proportional to the number of lines of magnetic force cut in a given time. He learns also that the numerical value of the voltage is the same but reversed in direction when the cutting of the flux is in the opposite direction. It makes no difference whether the wires move across the magnetic lines or the lines are caused to move so as to be cut by the wires, the value of the voltage is the same, provided the rate of cutting is constant.

In a transformer we have an example of the condition where the lines of force are caused to move across the wire. The secondary coil or coil in which voltage is induced is placed upon the same core as another coil called the primary, which has alternating current passed through it from some outside source. The lines of magnetic force, as they are set up by the primary coil, are caused, by their location, directed by the iron core, to cut the wires of the secondary coil, thus generating an electromotive force in it. This force lasts only while the flux in the core is changing in value.

At each reversal of the current in the primary there is a reversal of the magnetic lines, and a reversal of the electromotive force in the secondary coil takes place at the time the magnetic flux reaches a maximum in either direction and starts to decrease. The primary and secondary currents are 90 deg. out of phase, but this does not affect their numerical values.

Magnetic Action

In a correctly designed transformer, practically all of the lines of force set up by the primary current pass through the iron core and in doing so they cut across the secondary winding. The number of these lines of force is proportional to the ampere turns (or amperes X turns) of the primary. The primary current is kept from reaching a high value by the reaction of the secondary coil, caused by the fact that the induced current in the secondary coil rises to a value which makes its ampere turns equal to those of the primary, less what is necessary to overcome the losses in copper wire and iron core.

Since the number of lines of force set up by the primary is equal to that cut by the secondary coils, the voltages are in direct proportion to the number of turns in each. Thus if a 1,000-volt primary has 1,500 turns in it, the secondary, delivering a voltage of 100, will have 0.1 as many turns, or 150.

Ratio of Turns on Windings

The current relations are just the reverse of this. The primary with 1,500 turns and 5 amperes has $5 \times 1{,}500 = 7{,}500$ ampere turns; the secondary with 150 turns would deliver $7{,}500 \div 150 = 50$ amperes. It may therefore be stated that the voltages of a transformer in primary and secondary are directly proportional to the number of turns, while the currents are inversely proportional to the number of turns.

Required Conditions

When one starts to design a transformer or any part of it there are certain limiting or required conditions which must be met; these are usually a given capacity, voltage and voltage ratio, frequency, efficiency, ratio of iron and copper losses, temperature rise and regulation. The National Board of Underwriters requires a breakdown voltage test which also must be met and occasionally transformers for a specific location and duty require that the mechanical design be special.

Data for Example

The following design is for a core type lighting transformer and has been worked out with the following specifications to be met: Capacity of transformer 5 kilovolt amperes; high-tension voltage, 2,200; low-tension voltage, 110; frequency, 60 cycles per second; efficiency, 94 per cent or more; iron and copper losses, about equal; temperature rise, not over 45 deg. C. (113 deg. F.) in 8 hr.

Turns on Coils

A cross-shaped section of iron was chosen as the most convenient shape with a cross-section of 24.05 sq. in. and with this as a basis assuming a density of 3,200 magnetic lines per square centimeter (20,650 lines per square inch) as good practice, we then have sufficient data to find the number of turns required for either winding. The rule for this is: Multiply the voltage (either primary or secondary) by 2.25 times 10,000,000 and divide the product by the frequency times the cross-sectional area of the core in square inches times the inductance in lines per square centimeter times 6.45.*

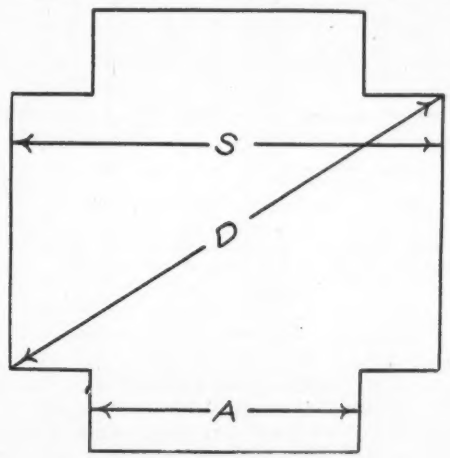


FIG. I. CROSS-SECTION OF CORE

*Expressed algebraically this becomes:

$$T = \frac{V \times 2.25 \times 10{,}000{,}000}{f \times A \times N \times 6.45}$$

in which T is the total number of turns in either the primary or secondary winding when V is the corresponding voltage, f is the frequency in cycles per second, A is the area of the core in square inches and N the inductance per square centimeter.

From this we get the number of low-tension turns

$$= \frac{110 \times 2.25 \times 10{,}000{,}000}{60 \times 24.05 \times 3{,}200 \times 6.45} = 83.5$$

Since there are 2 coils and we cannot have a part of a turn we will use 84 as the number of turns for the 2 low-tension coils, giving 42 turns to each. The turns in the high-tension coils will be $20 \times 84 = 1{,}680$, since the voltages are in the ratio of 20 to 1.

Substituting the value for the number of turns as found, and working back to find the inductance which is necessarily changed when we do not use 83.5 as the number of turns, we get our inductance as 3,180 lines per square centimeter.

Winding Detail, Wire and Insulation

For a transformer of this size it is decided that the best arrangement is to wind the low-tension on a cylindrical form, then when that is complete a layer of insulating material is wrapped over it and the high-tension coil is wound directly upon this.

In selecting the size wire to be used 2 things must be kept in mind, its current carrying capacity and the

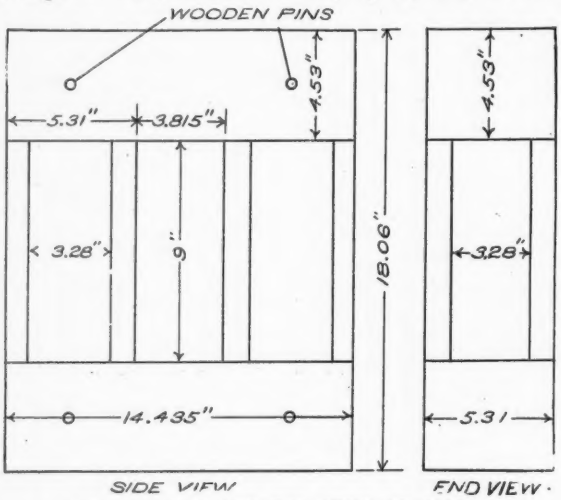


FIG. 2. SIDE AND END VIEW OF CORE

mechanical ease with which it can be handled. The low-tension coil must carry a current equal to

$$\frac{5{,}000}{110} = 45.5$$

amp. and upon looking in the wire table we find that No. 5, B. & S. double-cotton-covered wire, 2 wound in parallel, will answer as available for this coil. By inspection it will be seen that good proportions of the coil can be had by winding these coils in 2 separate layers, of 42 turns each, which are connected in parallel.

The inside diameter of the coil is fixed by the dimensions of the core and the insulation required. The greatest diameter of the core is 6.25 in., upon each corner is placed an insulating cardboard 3/32 in. thick, upon this is wrapped cotton tape which, together with the paper upon which the coil is wound, makes the inside diameter of the coil 6.5 in. The outside diameter is equal to this plus 4 times 0.1957 in. (the diameter of No. 5 double-cotton-covered wire) plus 1/8 in. for treated cloth insulation between the high and low-tension coils, making it 7.4078 in. The length of the coil is $(42 \times 0.1957 =)$ 8.22, plus 3/8 in. at each end for insulation and space for securing the wire, gives 8.97 in. as the total length.

For the high-tension the size of wire which seems best adapted to carry the current of 2.775 amperes is No. 15 double-cotton-covered, 0.0671 in. diameter, which will be wound in layers of $8.22 \div 0.0671 = 122$ turns, directly outside the low-tension coil, making in all, $840 \div 122 = 6\frac{106}{122}$ layers. Between layers will be placed a layer of treated cloth insulation sufficient to withstand 3 times normal voltage between layers which will be about 1,000 volts and require one thickness of good cloth. The outside diameter of the coil can now be calculated, being equal to the inside diameter plus twice the diameter of the wire times the number of layers and the total insulation and binding tape, or $7.4078 + 2\ (7 \times 0.0671 + 0.125) = 8.5958$, or practically 8 5/8 in.

Copper Loss

We may now calculate the copper loss, which is equal to the resistance times the current squared. For

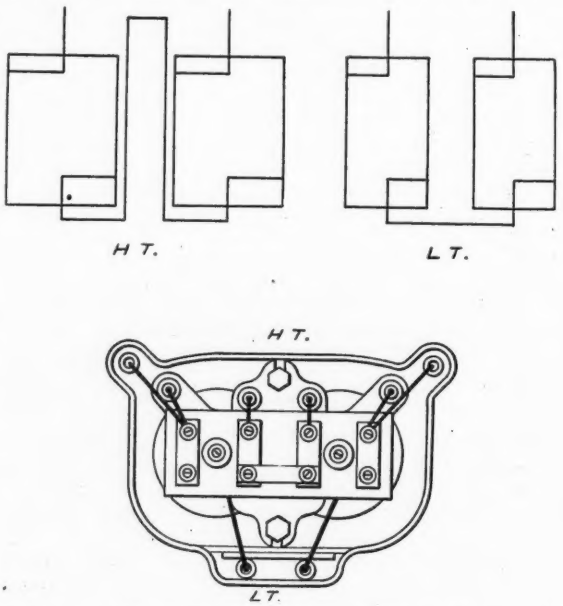


FIG. 3. CROSS CONNECTIONS AND METHOD OF BRINGING OUT LEADS

the low-tension coils the mean diameter is $(6.5 + 7.4078) \div 2 = 6.9539$ in., the resistance of No. 5 wire 2 in parallel is $0.0003128 \div 2 = 0.0001564$ ohm per ft. and there are 84 turns carrying 45.5 amperes, which gives

$$\frac{6.9539 \times 3.1416}{12}$$

$= 1.82$ ft. = length of one turn; $1.82 \times 84 = 152.8$ ft. = total length of wire; $152.8 \times 0.0001564 = 0.0238$ ohm. = total resistance; $0.0238 \times 45.5^2 = 49.2$ watts = loss in low-tension coils at full load.

In the same way we calculate the high-tension loss: The mean diameter of the coil is $(7.4078 + 8.625) \div 2 = 8.0164$ in.; $\frac{8.0164 \times 3.1416}{12} = 2.098$ ft. = length of one turn; $2.098 \times 1680 = 3523$ ft. = total length of the wire; 3523×0.003179 (the resistance per foot of No. 15 wire) = 11.19 ohms = total resistance, $11.19 \times 2.775^2 = 86$ watts for the full load loss in the high-tension coils.

This makes the total copper loss $49.2 + 86 = 135.2$ watts.

The next point in the design is the calculation of the iron dimensions and losses. The cross section of legs was taken as cross form, which is that shown in Fig. 1. The diameter, D, was taken as 6.25 in., the other dimensions would be $A = 3.28$ and $S = 5.31$ in. This makes a cross section of 24.05 sq. in. In order to give room for the coils the legs must be 9 in. long between yokes. The length of the yoke is determined by the diameter of the coils, thus the distance from center to center of the coils is equal to the outside diameter of one coil plus 0.25 in. clearance space, or $8.625 + 0.25 = 8.875$ in., giving a space in the center of the core 3.815 by 9 in.. the other dimensions being as shown in Fig 2. For convenience the cross-section of the yokes is made rectangular 4.53 by 5.31 in., giving a cross-section area of 24.05 sq. in., the same as the legs.

Iron Loss

We now have sufficient data to calculate the iron losses, which consist of hysteresis and eddy current losses, and are obtained by the following rule: The hysteresis loss is equal to a hysteresis constant, depending upon the quality of the iron, which in this case is taken as 0.000,000,000,25 times the volume of the iron in cubic centimeters (16.387 × volume in cu. in.) times the frequency times the inductance in lines per square centimeter raised to the 1.6 power (this is done by the use of logarithms). The eddy current loss is equal to a constant, depending upon the iron and taken as 0.000,000,000,016 in this instance, times the volume in cubic centimeters times the frequency squared times the thickness of the laminations squared times the inductance per square centimeter squared.*

The volume of the iron equals twice the length of the yoke plus twice the space between the yokes, all multiplied by the cross-section, or $24.04 \times (2 \times 14.435 + 2 \times 9) = 11{,}270$ cu. in., or $11{,}270 \times 16.387 = 18{,}430$ cu. cm. By substituting our values we then have for the total iron losses:

$$0.000{,}000{,}000{,}25 \times 18{,}430 \times 60 \times 387{,}100 + 0.000{,}000{,}000{,}016 \times 18{,}430 \times 60^2 \times 0.0356^2 \times 3180^2 = 120.6 \text{ watts.}$$

This makes a total loss of $135.2 + 120.6 = 255.8$ watts and the per cent loss will be $255.8 \div 5{,}000 \times 100 = 5.12$, the calculated efficiency will then be $100 - 5.12 = 94.88$ per cent.

The Case and Radiation

The next consideration of proportions is the case. There is little to be said about this, the only necessary requirement being that it shall have sufficient radiating surface to carry off the heat due to losses of the transformer. This surface is that only which is in contact with the oil and should be about 7 sq. in. for each watt loss, which will give a rise in temperature of about 32 deg. C., which in this case is 255.8 times 7 = 1790.6 sq. in.

The rest of the design is principally from a mechanical standpoint, making sure that all leads are well insulated and that the various parts have sufficient strength.

To insure correct polarity the high and low-tension leads should be brought out of the case in such a relation that while the high-tension current is flowing into the transformer on one side the low-tension lead on that side of the case is carrying current away from the case. The surest way is to wind all coils in the same direction and then cross the leads if necessary inside the case. The arrangement shown in Fig. 3 does not require crossing the leads, but under conditions where several voltages are required the problem of bringing out the terminals becomes quite perplexing.

It will be seen that according to calculations this transformer will meet all conditions required, but the only absolute proof of this is to test the apparatus after it has been built, although as a rule the results of a test are reasonably close to the calculations.

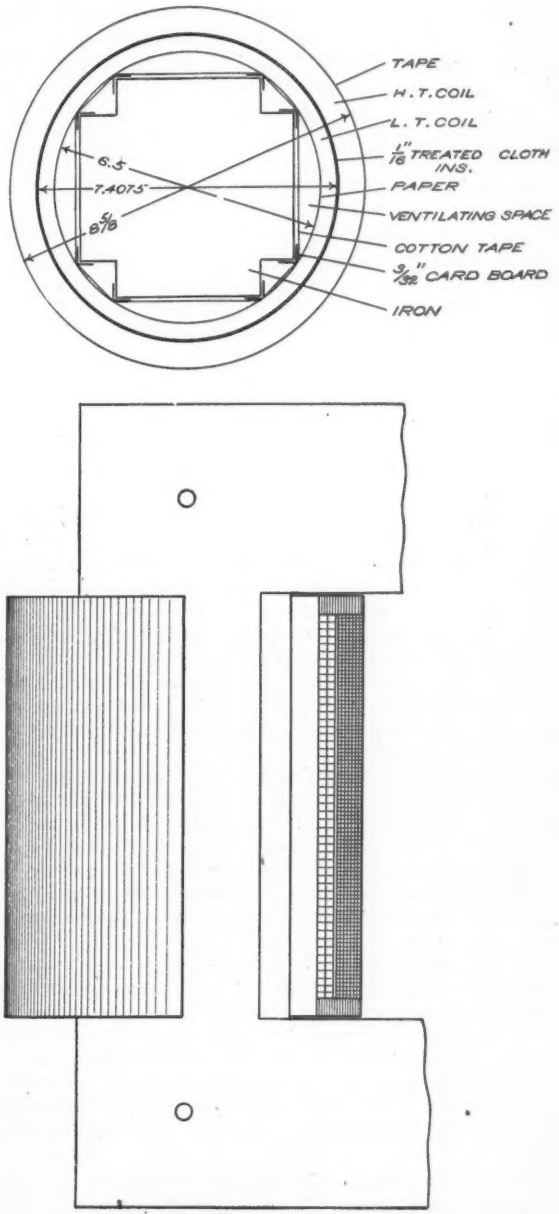


FIG. 4. SECTIONS OF TRANSFORMER SHOWING INSULATION

*When expressed algebraically this becomes:

$$W = aVfB^{1.6} + bVf^2 l^2 B^2$$

In which W is the watts lost; a is the hysteresis coefficient and is taken as $2.5 \div 10^{10}$, which is an average value for annealed refined wrought iron; V is the volume in cubic centimeters; f is the frequency in cycles per seconds; B is the inductance in lines per square centimeter; b is a constant depending upon the electrical resistance of the iron and is taken as $1.6 \div 10^{11}$ as an average for ordinary iron; l is the thickness of the laminations in centimeters and is taken as 0.0356 in our case.

WHAT THE COAL MINE HOISTING ENGINEER MUST KNOW

AT ANY RATE, PART OF IT

By Andrew Flesher

THE hoisting engineer should be given careful consideration along with millions of tons of coal he has hoisted to the earth's surface. He has a vast deal of drudgery to endure in order to become a successful engineer; his first step toward this vocation in life, is before a battery of boilers with a No. 1 or a No. 2 shovel in his hands and about a No. 12 wheelbarrow at his side, with one eye on the water glass, and the other on the steam gage, working like a demon for promotion to a higher position, with an increase in salary. Upon the training he receives in the boiler and engine room will depend the question of his existence, as the responsible position of hoisting engineer does not come to every man who serves his term of 2 yr. in the boiler room as the laws of Illinois require of him, before he can take the examination to the higher position.

After he has served his 2 yr. and appears before the State Mining Board, he may not be able to pass the examination and receive a certificate of competency, for at this point are many who fail along with a few who are successful; and often men that are successful before this board, are total failures when the responsibility of being placed in charge of a mining plant, the keeping up of mining machinery, and the handling of hoisting engines falls upon them.

Many of these failures are because they have sought advancement through letters of recommendation and the influence of friends, instead of trusting to real fitness and worth, and preparing themselves with the practical knowledge that comes to every skilful engineer through hard labor. The unskilful engineer may make one mistake and the great dial that marks the travel of the cages, loaded with men, may send them all into eternity; while the skilful engineer is the man who has his engines thoroughly under control, ready for decisive and vigorous action at any time.

He has come into possession of this skill by his practical, everyday work, giving his spare time to the study of problems that arise each day.

First, we will see what it requires to secure a certificate of competency before the Illinois State Mining Board, and quote the hoisting engineers' portion of laws, which he must know; following these laws we will take up the practical work of the man at the throttle.

Illinois Laws for Hoisting Engineers

Persons seeking certificates of competency as hoisting engineer must produce evidence satisfactory to the board that they are citizens of the United States, at least 21 yr. of age, that they have had at least 2 yr. experience as fireman or engineer of a hoisting plant, and are of good repute and temperate habits. They must be prepared to submit to and satisfactorily pass an examination as to their experience in handling hoisting machinery, and as to their practical and technical knowledge of the construction, cleaning and care of steam boilers, the care and adjustment of hoisting engines, the management and efficiency of pumps, ropes and winding apparatus, and their knowledge of the laws of this state in relation to signals and the hoisting and lowering of men at mines.

LOCATION OF ENGINE AND BOILER-HOUSE

Any building erected after the passage of this act, for the purpose of housing the hoisting engine or boilers at any shaft, shall be substantially fireproof, and no boiler house shall be nearer than 60 ft. to the main shaft or opening, or to any building or inflammable structure connecting therewith.

BRAKE ON THE DRUM

Every hoisting engine shall be provided with a good and sufficient brake on the drum, so adjusted that it may be operated by the engineer without leaving his post at the levers.

FLANGES ON EACH END OF THE DRUM

Flanges shall be attached to the sides of the drum of any engine used for hoisting men, with a clearance of not less than 4 in. when the whole rope is wound on the drum.

CABLE FASTENINGS MUST BE SECURE

The ends of the hoisting cables shall be well secured on the drum, and at least 2.5 laps of the same shall remain on the drum when the cage is at rest at the lower caging place in the shaft.

INDICATOR TO SHOW POSITION OF CAGES

An index dial or indicator, to show at all times the true position of the cages in the shaft, shall be attached to every hoisting engine for the constant information and guidance of the engineer.

CODE OF SIGNALS TO BE PLAIN AND IN FRONT OF ENGINEER

The code of signals, as provided for in this act, shall be displayed in conspicuous letters at some point in front of the engineer when standing at his post.

GAGES FOR BOILERS

Every boiler shall be provided with a steam gage, properly connected with the boiler except where 2 or more boilers are equipped and connected with a steam drum, to indicate the steam pressure, and another steam gage shall be attached to the steam pipe in the engine house, the 2 to be placed in such a position that both the engineer and fireman can readily see what pressure is being carried.

Such steam gages shall be kept in good order and adjusted and be tested as often at least as every 6 mo.

SAFETY VALVES

Every boiler or battery of boilers shall be provided with a safety valve of sufficient area for the escape of steam, and with weights and springs properly adjusted.

INSPECTION OF BOILERS

All boilers used in generating steam in and about coal mines shall be kept in good order, and the operator of every coal mine where steam boilers are in use shall have said boilers thoroughly examined and inspected by a competent boiler maker or other qualified person not an employe of said operator, as often as once in every 6 mo., and oftener if the inspector shall deem it necessary, and the result of every such inspection shall be reported on suitable blanks to said inspector.

UNLAWFUL TO EMPLOY OTHER THAN CERTIFICATED HOISTING ENGINEERS

It shall be unlawful for the operator of any mine to employ, or suffer to serve, as hoisting engineer for said mine, any person who does not hold a certificate of competency issued by a duly authorized board of examiners of this state, or to permit any other to operate his hoisting engine except for the purpose of learning to operate it, and then only in the presence of the certificated engineer in charge, and when men are not being hoisted or lowered; Provided, that whenever any exigency arises by which it is impossible for any operator to secure the immediate services of a certificated hoisting engineer, he may place any trustworthy and experienced man, subject to the approval of the state inspector of the district, in charge of his engines, to act as temporary engineer, for a period not to exceed 30 days.

CARE OF ROPES AND CAGES

The mine manager or superintendent must have special attention given to the condition of the hoisting ropes; they must be carefully and frequently scrutinized. Before the men are lowered in the morning the soundness of the ropes must be tested by hoisting the cages. He must also have the cages, safety catches, pumps, sumps and stables examined frequently; he must have the mine examined every morning by the mine ex-

aminer before the men are allowed to go to work, and know that the top man and bottom man are on duty, and that sufficient lights are maintained at the top and bottom landings when the men are being hoisted and lowered.

DUTY OF HOISTING ENGINEERS AND THEIR CONSTANT ATTENDANCE

The hoisting engineer at any mine shall be in constant attendance at his engine or boilers at all times when there are workmen under ground.

NO OUTSIDER ALLOWED IN ENGINE-ROOM

The engineer shall not permit any one to enter or loiter in the engine room, except those authorized by their position or duties to do so, and he shall hold no conversation with any officer of the company or other person while the engine is in motion or while his attention is occupied with the signals. A notice to this effect shall be posted on the door of the engine house.

CARE OF ENGINE AND BOILERS

The engineer or some other properly authorized employe must keep a careful watch over the engine, boilers, pumps, ropes and winding apparatus. He must see that his boilers are properly supplied with water, cleaned and inspected at frequent intervals, and that the steam pressure does not exceed the limit established by the boiler inspector; he shall frequently try the safety valves and shall not increase the weights on the same; he shall observe that the steam and water gages are always in good order, and if any of the pumps, valves or gages become deranged or fail to act he shall promptly report the fact to the proper authority.

MUST UNDERSTAND THE SIGNALS

The engineer must thoroughly understand the established code of signals, and these must be delivered in the engine room in a clear and unmistakable manner, and when he has the signal that the men are on the cage he must work his engine only at the rate of speed hereafter specified in this act.

HANDLING OF ENGINES

The engineer shall permit no one to handle or meddle with any machinery under his charge, nor suffer any one who is not a certificated engineer to operate his engine, except for the purpose of learning to operate it, and then only in the presence of the engineer in charge, and when men are not on the cage.

CODE OF SIGNALS AT MINES

At every mine operated by shaft and steam power, the means of signaling to and from the bottom man, the top man and the engineer, shall consist of a tube, or wire incased in wood or iron pipes, through which signals shall be communicated by electricity, compressed air or other pneumatic devices or ringing of a bell. The following signals are provided for use at mines where signals are required:

From the bottom to the top: One ring or whistle shall signify to hoist coal or the empty cage, and also to stop either when in motion. Two rings or whistles shall signify to lower cage. Three rings or whistles shall signify that the men are coming up; when return signal is received from the engineer, men will get on the cage and cager shall ring or whistle one to start. Four rings or whistles shall signify to hoist slowly, implying danger. Five rings or whistles shall signify accident in the mine and a call for stretcher. Six rings or whistles shall call for a reversal of the fan.

From top to bottom, one ring or whistle shall signify: All ready, get on cage. Two rings or whistles shall signify: Send away empty cage. Provided, that the operator of any mine may, with the consent of the inspector, add to this code of signals in his discretion, for the purpose of increasing its efficiency or of promoting the safety of the men in said mine, but whatever code may be established and in use at any mine, must be conspicuously posted at the top and at the bottom and in the engine room, for the information and instruction of all persons concerned.

SPEED OF CAGES, AND OTHER REGULATIONS

Cages on which men are riding shall not be lifted nor lowered at a rate of speed greater than 600 ft. a minute, except with the written consent of the inspector. No person shall carry any tools, timbers or other materials with him on any cage in motion, except for use in repairing the shaft, and no one shall ride on a cage containing either a loaded or empty car. No cage having an unstable or self-dumping platform shall be used for the carriage of men or material, unless the same is provided with some convenient device by which said platform can be securely locked, and unless it is so locked whenever men or material are being conveyed thereon. No coal shall be hoisted in any shaft while men are being lowered therein.

FOR LARGE BELTS it is better to use a narrow thick belt than a broad thin one.

COST OF WATER POWER PLANTS

The accompanying table of estimated costs per horsepower of water power plants which was prepared by Charles T. Main, gives approximate figures for ordinary conditions and should be useful in making rough preliminary estimates. It is to be noted that the costs of dam, canal, and buildings are not included for these of necessity will vary greatly with the locality.

Table of Estimated Costs per Horsepower of Water Power Plants

Having horizontal turbines, steel penstocks and walled tailraces—dam and buildings not included.

	"L." ft.	10-ft. fall.	20-ft. fall.	30-ft. fall.	40-ft. fall.
1,000 hp.....	200	$71.91	$32.84	$21.70	$16.38
"	400	85.43	39.77	26.32	19.95
"	600	98.96	46.69	30.94	23.53
800 hp.....	200	72.22	33.12	21.98	16.78
"	400	85.70	40.04	26.56	20.35
"	600	99.15	46.98	31.17	23.93
600 hp.....	200	72.64	33.49	22.34	17.20
"	400	86.20	40.45	26.95	20.87
"	600	99.76	47.42	31.57	24.54
400 hp.....	200	73.16	34.05	23.10	17.82
"	400	86.90	41.03	27.73	21.45
"	600	100.65	48.03	32.35	25.08
200 hp.....	200	75.35	35.97	24.97	19.47
"	400	89.10	43.56	29.70	23.21
"	600	102.85	50.60	34.43	26.95

"L" is the distance from source of supply to the plant.

In a large number of water power developments examined by Mr. Main, he found that a large percentage had been developed with wheel capacity sufficient to use all of the water from 6 to 7 mo. in an average year, and during the remaining months water would go to waste. The period of economical development varied with each particular case; in some instances it was stated by engineers to be 9 mo. It is this variation which complicates the problem of the economical development of water power.

The cost of the dam will be a constant for any size of wheel development, other things being equal. The head gates, canal, racks, feeders, wheels, wheel-pits, and tailraces must be increased in size and cost for the purpose of using a larger amount of water.

AS THE COAL SUPPLY IS DEPLETED and the price of different coals increase, the secondary fuels become of importance and peat is one of those likely to be used. Several experts state that millions of dollars' worth of fuel lie in the swamps and bogs of the country, the estimate being $38,000,000 at $3.00 a ton. It is doubtful if the fuel is worth that amount as it lies, but is possibly worth that after prepared and ready for the market. Peat is well distributed throughout the northern tier of states from New England to Dakota and is found in some parts of the South. The use of peat in the older countries is much farther advanced than in the United States, as has been found by Prof. Fernald, on a recent trip through Europe. He reports that during the last 8 yr. bogs have been consistently added to the worked list, some 2,000 to 5,000 tons being used for power purposes each year. The power plant is placed directly in the peat bog, and electric current transmitted to the surrounding towns. For gas producer use, peat is especially well adapted since the 15 to 20 per cent of water which remains in the peat after drying can be turned to good account in the making of producer gas.

The Great January 1, 1910, Number

Engineers have been waiting to know what Practical Engineer will offer in the special issue for January, 1910, and have been expecting, of course, that it would be an issue of at least equal value to the Feed Water Number. It will be, and on a subject of equal importance.

The most important thing in establishing good practice is to get your fundamentals right, and the fundamental things in power plant operation are water and fuel. Last January the water question was treated at length and completely. For January, 1910, the fuel and furnace question will be treated just as completely.

Under the best conditions of power plant operation—in the near-ideal condensing plant—only 10 per cent of the heat value of fuel is converted into usable energy.

With a faulty furnace, carelessness or incompetence, the available heat may quickly be reduced to 5 per cent or even less, which proves the necessity for complete information and thorough knowledge of good furnace practice with the ability to follow it in actual operation.

In view of this fact, Practical Engineer will, on January 1, 1910, serve its engineer readers with a complete treatise on Fuels and Furnace equipment. It will give them in one big issue—between two covers—a practical presentation of the subject which they could obtain in no other way except by laboriously and painfully reading volume after volume containing either an enormous amount of irrelevant matter or matter restricted to one small branch of the subject.

This Fuel and Furnace number will start with a clear presentation of the processes of Combustion—explaining that union of the Combustible Material of a Fuel and the Oxygen of the air. This process—the chemical change, the heat to break up, and heat given when combining, is shown as a simple chemical process, its success depending on the size and character of fuels used, type of furnace, draft, impurities in fuel and the extent to which mechanical difficulties are overcome to render oxidation comparatively complete. The difference between CO (improper) and CO_2 (proper) combustion will be pointed out and when "Combustion" has been treated from every practical angle, methods for Testing Correctness of Combustion, Analyzing Gases, and Temperature Tests will be given so that every engineer who gets the Fuel and Furnace number can make these tests himself.

Then come furnaces. Here tangible equipment will be discussed. The different types of furnaces shown. Equipment for obtaining good combustion and smokelessness and the purpose or function of such parts as ash pit, grates and combustion chamber will be practically presented. The furnaces best adapted for burning oil, coal, coke, peat, wood, sawdust, bagassee, gas, pul-

Fuels, Furnaces and Equipment

verized coal, briquettes, etc., will be both illustrated and described.

All successful oil burning systems will be shown, including burners, their manner of operation and fire box construction necessary for installing the different systems.

Under Commercial Apparatus of proven worth will be included the several types of mechanical stokers. The difference in construction and operation will be shown and how each is installed. The Chain Grate, Front Feed, Down Draft, Side Feed and Underfeed stokers will be classified and described as carefully as mechanical experts can describe such equipment.

The subject of Draft—natural and forced—and the commercial apparatus used in connection with forced draft will be taken up in full, as also will be the construction of front and side walls, boiler arches, bridge linings, settings and special forms of furnace construction, such as the Dutch oven and tile roof.

You see how complete this number will be. It will place in the hands of engineers a manual of modern furnace practice—practical guidance in the conduct of operation—designed to relieve them of unnecessary work, reduce fuel consumption in plants all over the world—create higher furnace efficiency, and save in manual labor and boiler repairs.

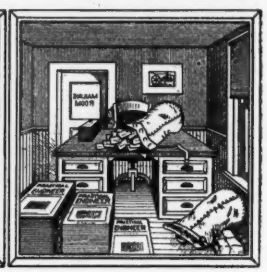
The Fuel and Furnace number will set a standard for proficiency as well as efficiency in the generation of steam and as such—through sheer editorial merit—will be looked upon and recognized everywhere as a work of influence against bad practice and authoritative and complete to a greater degree than any treatise of the subject ever before published in the technical press.

You ask the cost of getting this tremendously valuable issue. It will cost subscribers to Practical Engineer not one cent, for it is included in the year's subscription. If a man is not a subscriber, this issue will cost him 50 cents. You can see what a tremendous bargain the 2 years for $1.50 subscription offer is. Here you get first of all, with hardly a wait for it, the big Fuel and Furnace number, which will contain more information than any $2.50 book you ever bought and which you cannot buy alone for less than 50 cents. You will get besides this a special number in January, 1911, which will be just as valuable, although we are not prepared to tell you just now what the subject will be. You will get 22 other big issues, one each month, and for good measure you will get a valuable premium sent to you by return mail just as soon as payment for your subscription reaches us. If you own, install, operate or are interested in power plant machinery in any way, you cannot find any place on this round globe anywhere that $1.50 will bring you so much value.

PRACTICAL ENGINEER
355 Dearborn Street, Chicago, Ill.

Letters From Engineers

Tell us about your new kinks and new thinks. Rough sketches are always helpful; we make the drawings. Cash paid for accepted contributions.



Corliss Engine Regulation

We depend upon the momentum of the flywheel to a great extent in Corliss engines for any trivial change in speed or to absorb any small difference in load thrown on the engine. So an engine with a heavy wheel will regulate more closely on a fluctuating load than one having a light wheel; for this reason the engines that are intended for railway and rolling mill duty use a heavy balance wheel. This weight once in motion will tend to help the regulation, but the type of governor has much to do with the regulation of the engine.

Now we have some engines where the shaft of the engine makes 1 turn and the governor makes 1 revolution, while other types the governor will make 2 or more revolutions, depending upon the design. It would be clear that the engine which has the governor making the most revolutions would be more sensitive

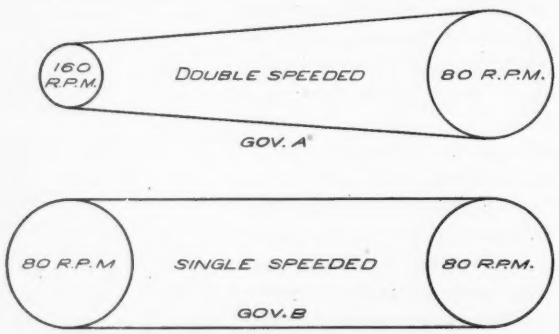


FIG. 1. RATIO OF GOVERNOR BELT WHEELS

to a change in speed than the one making fewer turns, or the fluctuation of the governor is depending upon centrifugal force or movement of the weighted arms.

So the double-speeded type would necessarily be more sensitive. In Fig. 1 are shown the 2 types, one running 80 revolutions while the engine makes the same number of turns as shown at B, while illustration A shows the double-speed type. Here our engine runs 80 revolutions and the governor is making 160. We also have shown the 2 rocker arms that are used with these 2 governors. Governor B has a long rocker arm, and is supposed to give a sensitive movement from C to B, while the movement from E to F is practically the same in both governors. In practice we find that the knock-out devices have much influence upon this long lever and cause some unsteadiness in the working of the governor, and this exceedingly long rocker arm has too much influence upon the governor.

A short rocker, such as is used on the multispeeded or Porter type of governor, is shown at A, Fig. 2. This governor has much more power upon this short arm and consequently makes the action quite positive. There is no giving of the governor caused by knock-out blocks. These points are well worth considering in buying a new engine and explain 1 reason why one governor regulates better than another. C. R. M.

Turning Down a Commutator

In the August number Mr. Kavanagh has some excellent illustrations of the methods to pursue in truing a commutator. I, however, beg to add a few suggestions as a practical machinist and engineer that he no doubt inadvertently omitted. The first thing to do is to see that the centers in the armature shaft have not been injured and are clean, next see that the lathe centers conform as nearly as possible with the armature centers, because if the centers have not surface equivalent with the weight of the armature the lubrication at the tail stock center will be forced out and the armature center start to cutting.

Now see that the live center runs perfectly true, set the centers in line, which can easily be done by

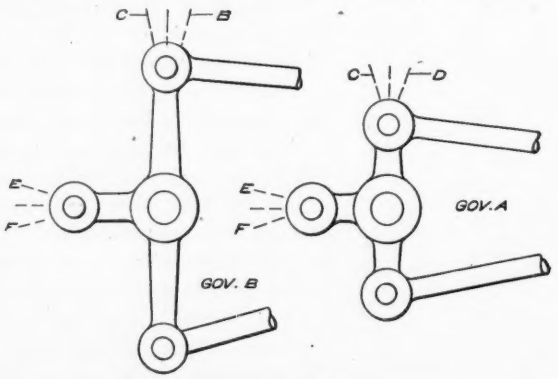


FIG. 2. GOVERNOR ROCKER ARMS

moving the tail stock up to the live center and adjusting it by the set screws that are on each side of every tail stock.

After getting the armature on the centers revolve it and see that the journals run perfectly true, as the centers may need some scraping in order to accomplish this. If, however, the journals should be irregular, then they must be trued up, taking off the least possible amount in order to avoid rebabbiting the boxes. This had better be done after the commutator is finished.

The tool used is much a matter of choice. I prefer the diamond point shown in the illustration, because you can get in the corner without changing tools, and as to filing the less filing that is done the truer will be the commutator, because of the difference in the hardness of the metal and the insulation. Whatever filing, however, is done should be done with a long file of the description mentioned, and draw the file its full length with an equal pressure and at a speed that will allow the commutator to make at least several revolutions for each stroke of the file, as by doing so,

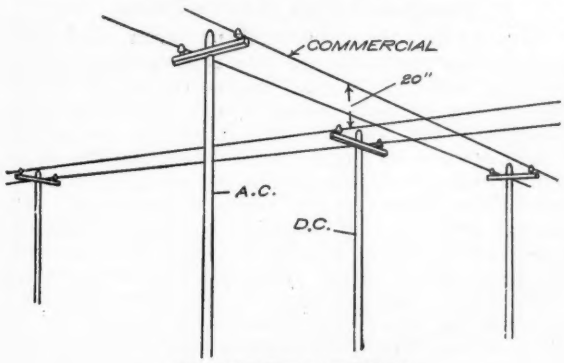
the chances of filing out of true will be minimized. The sand papering recommended by Mr. Kavanagh is excellent. Old Machinist.

A Hair Raising Experience

At the plant where I am employed we have a 50-kw. compound wound direct current machine that furnishes light at 120 volts to this plant and one farther up the street. The wires that run to the other plant cross the street over the trolley wires and under the commercial and street light wires, the last two carrying alternating current of about 2,500 volts.

One night I was feeling around our machine, just after the floor had been washed, when I was thrown against the wall. I had been stooping down when my hair came in contact with the uninsulated bars of the series field connections. I had no idea that my hair was such a good conductor.

The next week when I was on the day shift, and the machine was shut down. I told the chief and was



ARRANGEMENT OF LINES

illustrating the occurrence to him by brushing my hair against the same bars, when I was both surprised and shocked to receive the same dose from the dead machine as I did when it was making electricity.

We knew, then, that we were stealing somebody's electricity, so we sent for the superintendent of the lighting plant and he located the trouble. Where their wires crossed ours, they had sagged down to about 5 or 6 in., when they were formerly separated by 20 in., as illustrated. After the commercial wires were tightened up the trouble ceased.

What I would like to know is, why the electricity with the higher voltage did not burn our machine out when it was dead? And what effect it had upon the machine when it was running. Everything seemed normal and the machine carried full load and sometimes more? A. N. G.

Truing Up a Fan

A large fan that was installed in a plant last fall even when run at slow speed, would swing the entire framework surrounding it. The writer was called upon to put it in proper shape and while there was nothing original about the method employed, it may be of interest to some readers.

It was thought that the fan wheel was out of balance so the clearance between the wheel and the case was measured and found sufficient to allow the shaft to turn a complete revolution. The shaft was uncoupled from the engine and after removing the caps from the boxes, it was jacked up, the boxes removed and the shaft let down on steel parallels placed beneath it. The parallels were then accurately leveled up and clamped, leaving the wheel free to revolve until the heaviest part was down.

Small clamps were fastened on the blade that sought the uppermost position until the wheel balanced perfectly at all points. After marking their positions on the blade, the clamps were removed and weighed. At the marks on the blade holes were drilled and tapped and permanent balance weights weighing a trifle more than the clamps, enough to allow for the metal removed in drilling the holes, were fastened on.

When the fan was set up in running condition again the engine was examined and it was found to have enormous compression on 1 end and practically none on the other end. After the valve was adjusted and the engine connected up, it ran without shake except on excessive speed. W. F. B.

A Cheap Engineer

In a modern office building there was installed everything that goes to make it as convenient as possible for the tenants and also for those who had the care and management of it. The building consisted of several offices on the 4 upper floors and stores on the ground and second floor. To heat the building and to get power for elevators and lights there were installed 2 horizontal return tubular boilers at 100 hp. each and an engine that used to do 75 hp.

The engine was secondhand and was in good condition, but was larger than was necessary for the size of the building. At that time everything that was installed outside of the engine was new and in the best of shape. As the building was nearly completed a competent man was wanted to look after the steam boilers and engine, and one was secured who knew his business, gave entire satisfaction, and was well liked by all he met because of his cheery disposition.

The manager of a neighboring office building asked him if he would like to work for him and offered him more pay than he was then getting. So he decided to get the most for his labor and went to the man giving the most money, and a sign was put up in the office of the manager he left. A man was hired who did not know the difference between a wash boiler and a steam trap and would often ask what was the use of that thing on the wall, meaning a Mason damper regulator, and a lot of other such questions.

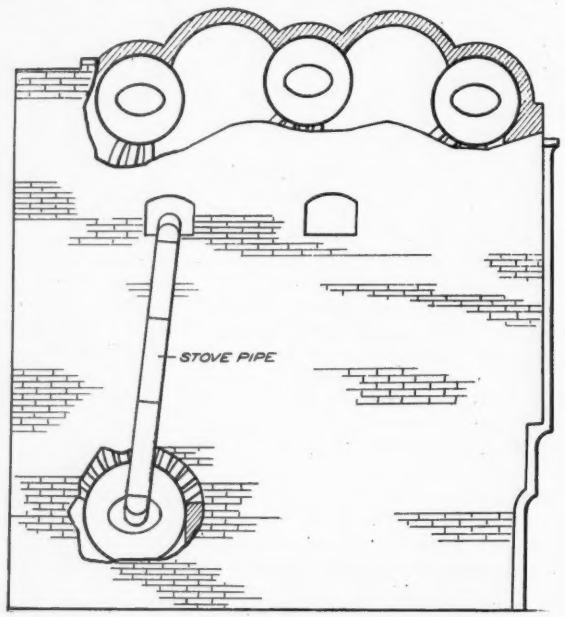
The cold weather was coming on and the capable man was busy a few doors away getting things in first-class shape for his hard season, and to show his employer that he made no mistake when he hired him; while the incompetent man was putting things that were in order out of order because he did not know what they were or what good they would do. His first attempt at making right wrong was successful. He began monkeying with the damper regulator and after he was done it would not work, so he told the manager it was too slow and he could get along better without it by using the hand dampers, and of course it went, and so did the coal.

The boiler feed pump, according to his story, was giving trouble, and he undertook to fix it, and when he got through the manager had to have a mechanic put it in working order. During the time the pump was being repaired the injector was having hard things said about how it would kick for no cause and all because he would turn on the steam first getting it all heated, but when it was handled as it should be it worked like a charm.

The safety valves on the boilers were set for 100 lb. but 80 lb. was enough for all it had to do, and it was reduced down to 15 for the heating system by reducing

valves. There were quite a number of complaints from the tenants not getting steam, and of course something had to be blamed, and the reducing valve was the trouble according to the engineer. So he tried to make it right, and when he got done it set up a humming and groaning that made the tenants think of the land of spirits. So a new valve was bought and put in place and all was well again he thought, until some more complaints came in, so he fussed around to find something that he could say was wrong, and he hit upon the steam trap, and as usual a new one was bought and installed, and everyone hoped that the trouble would be over, but no, the junk pile was growing larger and the coal pile was fast disappearing, and the manager said he would have to raise the rent on the tenants in order to make the place pay as well as it did in former years.

The manager was not a practical man and did not know where the waste was, if he did he did not stop it. After a while he found out and only after he



ARRANGEMENT FOR CLEANING STIRLING BOILERS

paid well for his lesson and almost lost his own job as manager. The man who owned the building had a vacant lot adjoining the building in question and decided to put up a hotel on it and have all the heating done from the old boiler room by adding another boiler.

The plan of the hotel called for a sub-basement for the purpose of storage, and as it was necessary to have it heated some in the winter it was here that the engineer, as we will call him, was found to be wanting in his knowledge of heating systems. The piping was put in as designed and after it was tried it worked all right; the water was returned to the boilers by the use of return traps and gave entire satisfaction. The boilers were fed by city water passing through a meter and thence through a heater to the pump and paid for each month. The engineer said he could not keep the place warm as the water of condensation or returns was leaving the pipes at 85 deg. That was too cold, so he decided to take the trap out and run the returns away to waste in the sewer. When the water bill was presented to the manager the first month was not so bad because it was wasting only a few days when the meter was read but the next month it took such a jump that a man would almost forget it was water and look for something stronger. So he investigated and found the water wasting and made no delay in getting a new man and if he knew his business he was willing to pay him good wages so that any inducements offered by his neighbors would not be accepted. No more cheap help for him. M. J. C.

Cooling Boiler for Cleaning

I enclose a little sketch of a method we use in keeping a Stirling boiler cool when cleaning it.

Take several pieces of old stove pipe and 2 elbows; insert one end in the mud drum manhole and the other in the soot door just above the mud drum. Close the ash pit doors and open wide the flue damper. Take off the upper manhole heads and one can work in any one of the upper drums, for it is quite comfortable.

E. A. L.

Stopping a Leak in Brine Tanks

A case where the resourcefulness of the engineer in charge of an ice plant has just been brought to the attention of the writer, and may be the means of getting another engineer out of trouble during the busy season and also avoid a serious loss to the owner. It was noticed for more than a week that the brine in the freezing tank was getting low and required additional brine, hence the first thing to do was to locate the leak and stop it if possible. The leak was finally found to be at one or more of the pipes that pass from the lower round of the expansion coils through the freezing tank and insulation to the lower manifold. This state of affairs would ordinarily require the removal of the insulation and try to stop it from the outside or stop the machine and empty the tank. In order to avoid this he took a piece of 2-in. pipe long enough to reach the bottom, then simply dropped cement in the pipe until the leak was stopped by the excessive accumulation of cement, part of it being forced into the aperture by reason of the brine pressure. Care must be taken not to put the cement in too fast or it will cake in the pipe.

This method of stopping the leak took some patience and a bag of cement, but it effectually did the work and above all, they continued to make ice when they needed it badly. W. S. Luckenbach.

Stopping Water Hammer

In answer to J. H. P.'s problem, "Hammering in Water System" appearing on page 496 of the August number of Practical Engineer, I would say that he can overcome his trouble by putting an air chamber on the discharge side of his pump between the pump and the check valve, this will produce a steady flow of water when the pump is running, and hold the check valve open all the time the pump is running, instead of allowing it to be opened and closed violently at each stroke of the pump as was done before. A good sized air chamber is all that is needed to stop the pounding and he will still have his check valve to hold the water from backing up. R. T. B.

Gage Testing By an Indicator

The diagrams herewith show a funny break at admission on the crank end. The engine is a Corliss 18 by 42 in. at 78 r. p. m., boiler pressure 93 lb., spring 40 lb. Why is it?

On the top of the boiler is a ¾-in. valve used for a vent, into which I screwed a ½-in. bushing and a

nipple, then a tee, then 2 short nipples. On one nipple I used a ½ to ¼-in. ell for a steam gage connection, and on the other I used a ½-in. ell, into which I screwed an indicator cock so as to connect the indicator.

I first heated up the cylinder of the indicator and gradually turned on steam until full boiler pressure

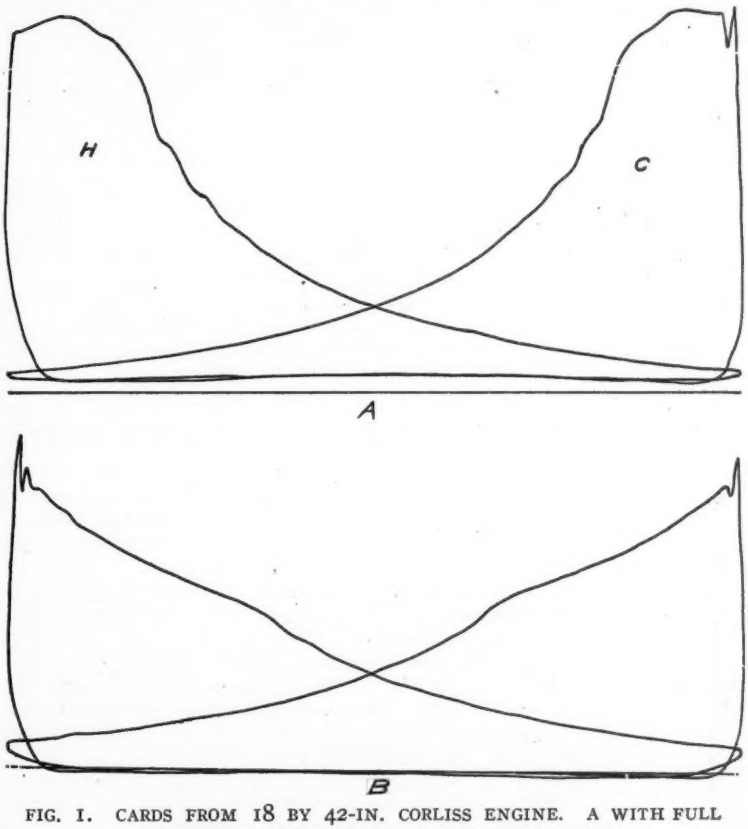


FIG. I. CARDS FROM 18 BY 42-IN. CORLISS ENGINE. A WITH FULL PRESSURE. B WIRE DRAWN BY THROTTLE VALVE

was on. Then drawing the indicator string and holding the pencil against the paper got line B, representing boiler pressure, which was 90 lb. by the gage.

After relieving the pressure on the indicator the

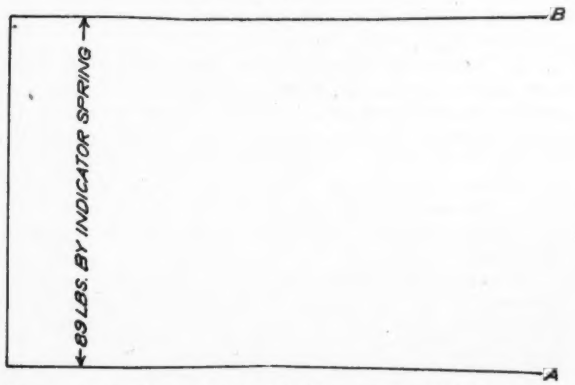


FIG. 3. DIAGRAM FROM INDICATOR WITH PRESSURE INDICATED BY GAGE

atmospheric line A was taken. The diagram taken with a 40-lb. spring shows by measurement 89 lb. After testing the steam gage by hydrostatic test, it was found that the pressure shown by the indicator was correct, as the gage was 1 lb. off.

Ed A. Freeman.

Charging a Storage Battery

Somewhere in this universe every man has his double, we engineers also have many parallel experi-

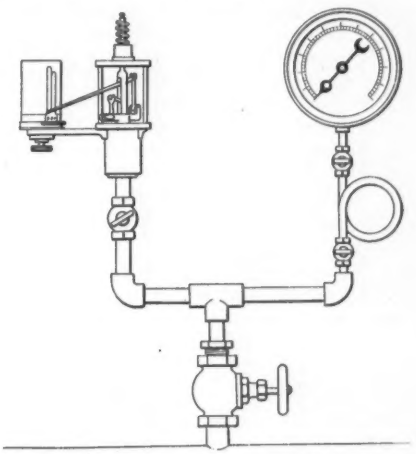
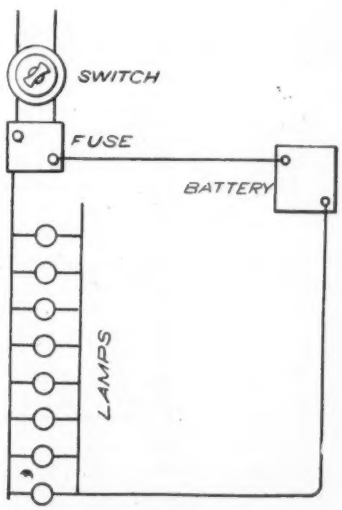


FIG. 2. ARRANGEMENT FOR TESTING GAGE



ARRANGEMENT OF WIRING FOR CHARGING STORAGE BATTERIES

ences. One morning early in the summer, the gentleman for whom I work, sent down his storage battery to be recharged; it was the portable type about 6 volts, 60 ampere hour capacity.

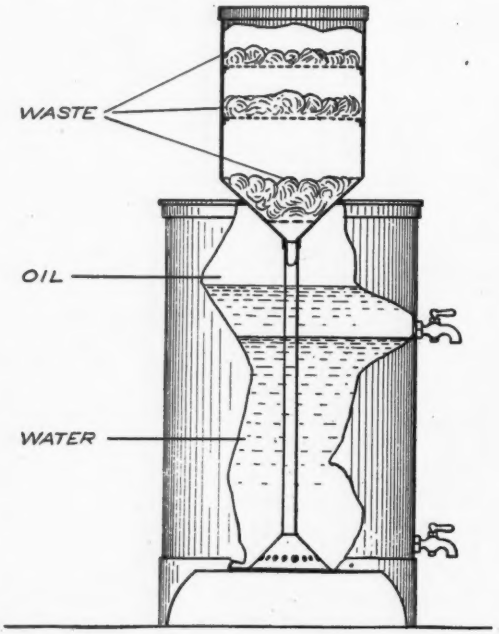
I first got 2 No. 14 B. & S. wires connected to a main and then found the direction of flow of the current, which can be determined by either a tumbler with dilute sulphuric acid or a compass. The 2 wires were then connected to a switch, a fuse block and next a bank of 8 32-candlepower, 220-volt lamps, thus connecting the positive wire to the positive pole on the battery. It was then charged for about 6 hr.; then I cut out 4 lamps and charged until the positive plate was nearly chocolate color, which can be seen from filling stoppers; in about 10 hr. it began to fume. I tested it and then had 2.5 volts per cell and stopped charging.

The battery is used for lighting a White automo-

bile, 2 6-volt incandescent lights in the center of the reflector in each side light, 1 over the gages and an extension cord used during trouble about the car. The battery has been charged twice in this manner this season, and has given good results. Geo. E. W.

Oil Filter; Saw Dust

A cheap filter that does good work is made as follows: Use an old discarded waste can that has several holes in it as the body, insert a pet cock at the bottom for the water, and attach an old bib from an ice cooler for the oil outlet. Two old 5-gal. oil cans, that leak at the bottom can be used; one as the filtering chamber can be made by cutting the bottom off about 1 in. up, leaving a rim, then spread out slightly, turn the cut edges a little and this bottom can be used as a cover. Now make a cover for the waste can of some light boards or tin, cut a hole a little smaller than the top of the oil can, so that it will rest on it. A piece of 1-in. pipe is now screwed or forced into the neck of the can, this should reach near to the bottom.



HOME-MADE OIL FILTER

Cut the top from the other can, a little smaller than the hole in the cover so that it can be removed and force over the lower end of pipe, this acts as a spreader for the oil. Put a piece of burlap or wire screen in the bottom of the filter chambers and waste on top of this. Several screens can be put in if desired, and hung on wires; a gage glass can be added if desired.

My filter cleans about 2 gal. of oil a day and the oil is as good as new. The filter did not cost a cent, it took about 3 hr. to make it, and has been in operation several months. I remove the top layer of waste about once a week, but the rest remains 2 months when I clean the whole apparatus. It is surprising how much dirt there is in the bottom of the water space. If kept in a warm place so that the water will be warm, it works better as the oil is clearer.

How many of us know the value of saw dust about the engine room? It is as good a cleanser as waste, and far cheaper. It is often considered a nuisance and burned up, yet I would rather be without waste than saw dust. If kept in a good can with a cover nobody will object to its presence and that which has been used can easily be burned.

Where there is always more or less oil and grease around the engine, a little saw dust thrown about will quickly absorb. When tools are dirty and greasy, I simply throw them in the saw dust can, rub them well and they come out bright and clean.

Oily hands are more easily cleaned with saw dust than with waste by giving them a good rubbing with it. Oil spilled anywhere is easily removed with saw dust by throwing some on the oil; let it remain a while, and then sweep up.

When burning saw dust or other rubbish, I place a board or several pieces on the fire, or if the fire is light, I clear a space in the center, place the board on the grate and the material to be burnt on top in a pile; open the damper wide and I get but little smoke. I get from 6 to 9 barrels of rubbish to burn every morning, and find this the best way to dispose of it. It makes a little smoke at first, but only for a few seconds, and when burned, leaves a clean place on the grate which is easily covered with coal.

R. T.

Practical Education and the Society of Operating Engineers

Referring to your editorial on Practical Education appearing in the August issue of Practical Engineer, I must say it was very timely, and I congratulate you on coming out for Practical Education.

Practice in an engine room and an education gained in some good school or college is a combination that is very hard to beat.

Mr. Jurgensen you will know has been the chief instructor of our Relief and Educational Society here in the Hotel St. Regis Engineers' Department since its organization 3 yr. ago, up until last May, when he severed his connection with this hotel.

It has been our aim to educate our members by giving them both practice and theory.

We started by taking young men into the engine room and putting them through the various positions and at the same time issuing to them questions and information on practical engineering, compiled by our chief instructor, to be taken home and studied and answered in their spare moments, after which they were returned to the chief instructor who would give the members a mark and any information or suggestions he might deem necessary.

Mr. Jurgensen found this to be of such great benefit to the men that he suggested we try to organize a society throughout the country to work along the same lines as our society, or even to go further by having some good schools and colleges take up the educational end for us, and as you know Mr. Jurgensen's efforts met with great success in having Columbia University give a course in Plant Management this fall.

It is now our desire to spread this society under the proposed name of Society of Operating Engineers, and I am glad to be able to send you a copy of the proposed constitution for the society.

Yours very respectfully,

Thos. J. Prime.

Constitution for the Proposed Society of Operating Engineers.

ARTICLE I.

NAME.

Section 1. This organization shall be known as the "Society of Operating Engineers."

ARTICLE II.

OBJECTS.

Section I. The object of the Society shall be to unite in one vocational Organization those who are vitally and directly interested in Operating Engineering, including Plant Owners as Associate Members.

Section II. To make education and apprenticeship for Operating Engineering equally important and interdependent.

Section III. To further friendly relations, a spirit of mutual helpfulness and practical co-operation, first, between the various grades of Plant Workers; second, between Plant Owners and their employes, that through increased co-operation and vocational pride among its members, the Operating Engineers' vocation may increase in prestige and make its industrial importance better appreciated by present and prospective members, as well as by Plant Owners and the public in general.

Section IV. To advocate and facilitate the introduction of a uniform nine hour work day for all Plant workers, as a means for increasing individual efficiency, as well as Plant efficiency, and also that the Operating Engineers' vocation may attract suitable young men as apprentices.

Section V. To advocate and facilitate the adoption of a uniform apprenticeship system for the training of Machinery Operators, Proficient Firemen, and Operating Engineers; also, to provide means for the technical education of apprentices, as well as for independent study of members.

Section VI. To facilitate the adoption of economical and thorough business methods in Building and Plant management.

ARTICLE III.

THESE OBJECTS ARE TO BE FURTHERED PRINCIPALLY BY

Section I. Facilitating the selection of young men as apprentices, who by nature possess the essentials needed for efficiency in the Operating Engineer's vocation.

Section II. Facilitating and advocating a systematic evening instruction course in schools and colleges in Operating Engineering, of at least three years' duration, for apprentices and others who have had at least two years' continuous practical experience in a Power Plant or a Machine Shop, and are properly prepared to enter the regular instruction course.

Section III. Establishing close interdependent relations between the Power Plant and the School Room, that under their co-operative and co-ordinate guidance, young men may serve a regular period as apprentices, and thus receive simultaneous vocational training in the practice as well as in the theory and principles of Operating Engineering.

Section IV. Authorizing the formation of local and district Organizations, to be known as branches of this Society, for the purpose of carrying out more effectually the objects of the Society.

Section V. Granting a two year service certificate to accepted apprentice members, and a four year service certificate to members who act as special Power Plant Mechanics.

Section VI. Granting apprenticeship certificates to properly qualified apprentice members with at least four years' experience, certifying the bearer to be either a machinery operator or a proficient fireman, and to award an Operating Engineer's membership Diploma to those who qualify in the practical work of machinery operators and proficient firemen, and who have successfully passed the prescribed course of study and have had at least five years' practical experience.

Section VII. Reading and distributing original essays and other papers concerning theory and practice, thus promoting and encouraging the study and discussion of conditions and methods in the vocation of Operating Engineering.

Section VIII. Providing a library and catalog of the works on Operating Engineering and kindred subjects available at various local libraries.

Section IX. Providing facilities for finding suitable and remunerative employment for members.

ARTICLE IV.

MEMBERSHIP.

Section I. The members of the Society shall consist of Honorary, Associate, Senior, Junior and Apprentice Members.

Section II. Honorary, Associate, Senior, Junior and Apprentice Members shall be equally entitled to the rights and privileges of the Society. Eligibility to the offices of the President and Vice-President shall be limited to Senior Members; Apprentice Members shall not be entitled to vote, nor to be Officers of the Society.

ARTICLE V.

BRANCH ORGANIZATIONS.

Section I. The proposers of new local branches are required to be men of the highest acknowledged standing.

To organize and affiliate as members of this Society, the branch Constitution must be subject to this Constitution in every detail.

Section II. The Branches are to be organized for the purpose of promoting locally, general and mutual helpfulness among its members in times of distress and accidents; furthermore, it must be the special object and duty of the branch organization:

1. To give such practical instruction and example in daily work as will further a spirit of manhood, and induce apprentices to become self-reliant, observing and manly men. Training such men to become safe and efficient Plant Workers, worthy to receive the Society Certificate of Merit for two years' continuous service in one Plant.

2. To vouch for and recommend to the Society young men who have proven their mechanical adaptability and moral worth during a two year probation period.

3. To guide and instruct probationary apprentices in the practical work required of them to enter the Society as accepted apprentice members.

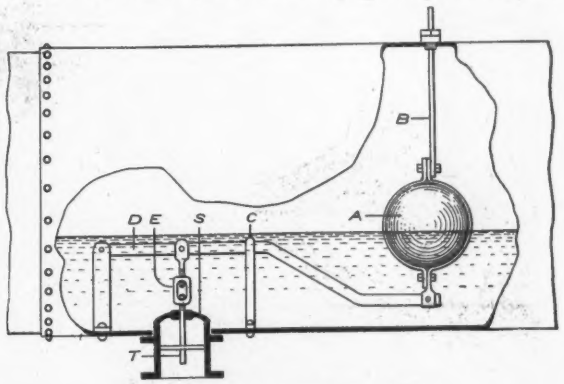
COMMITTEE.

Paul Nagel,	J. G. Ould,	H. M. Elder,
J. C. Jurgensen,	A. Harkness,	Thos. J. Prime,
L. Houmiller,	E. N. Ebbesen,	Paul Kindel.
	Eug. Connelly,	

All those desirous of joining in this movement will kindly communicate with the Secretary of the Organization Committee, Mr. A. Harkness, Hotel St. Regis, Eng. Dept., 5th Ave. and 55th St., New York.

Home-Made Valve

The condensed water from our juice evaporators is used for boiler feed water. It is collected in a large drum and from there it flows by gravity to the feed-



HOME-MADE AUTOMATIC VALVE

water tank. As we use only exhaust steam in the evaporators the pressure in this drum is practically nothing. The water flows by gravity and so the lead pipes come from the bottom of the drum and the weight of the water in the drum is always in a direction to have a tendency to close the valve. The discharge valve being 8 in. this weight was considerable. Since a balanced valve would hardly pay for itself we rigged up a valve as shown in the accompanying sketch.

The pressure of the water downward on the brass valve S is overcome by the copper float A, 14 in. diameter by 15 in. long, acting through the lever D. The small rod T working in the cross arm assures the seating of the valve; and in case of accident the valve can be opened by the rod B working in a small stuffing box on top of the drum. The guide C prevents the lever and float from getting out of line and the turnbuckle E allows adjustment to assure complete closing of the valve when the water falls below the specified level.

R. A. A.

IT HAS BEEN CALLED to our attention that in the issue of August, 1909, page 466, the printer omitted a minus sign from the equation for the diameter at the bottom of the thread of the staybolt. The equation should read: Diameter at the bottom of thread equals diameter of the bolt minus (pitch times 1.732).

THE GROWTH OF A GREAT WORKS

From great things on to greater is the war cry and the purpose of the Erie City Iron Works at Erie, Pa., and following this policy the management is always looking for new developments and improvements in steam machinery and new additions to its plant. Steam engines and boilers are the foundation products of the business. Searching out and using the best means and methods to give economy, fine service and durability are the foundation principles. As an instance from a talk with Thomas E. Durban, the general manager: "The reason for using solid ends on all rods,—connecting and valve—however small, is that this is the best construction we know." A cheaper construction would answer in many places, but he is looking for the best.

That, too, is why he uses Y forks on all rocker arms so that there is no side strain on arm or hanger stud. That, too, is why when it was discovered in the course of a test that the steam consumption of an engine could be cut 3 lbs. per hour per horsepower by using a good big separator so as to get dry steam, he decided to adopt superheating to ensure dry steam; and then went all over Europe to find the best valve system to use with superheated steam, finally selecting the Lenz engine valves and securing the rights for the United States.

And that is why the Erie City Works is bringing out a new vertical water-tube boiler with extra large steam space, and Foster superheater attached, so that the greatest convenience in handling may be secured. Always the search for the best way.

Engine building has been superseded by manufacturing here, complete engines being made in lots and stocked ready for shipment giving sure uniformity of excellence and interchangeability of parts.

Such policies are bound to result in growth, hence, we find the recent addition of the old Stearns Manufacturing Company's plant to the works and the building of a fireproof warehouse for storing completed parts and products. The illustration shows the middle bay down the big machine shop which was planned on the regular principle of getting the best way. A large center bay with passing cranes, 2 above and 1 below; side bays for the lighter work with compressed air hoists; galleries with side and turret lighting for governor and valve motion parts; heavy construction so that there is no vibration. The solidity and efficiency of the plant give guarantee of durability and efficiency in the output.

CENTER BAY IN THE MAIN SHOP OF THE ERIE CITY IRON WORKS

TIME SPENT in looking for a snap is worse than wasted. It might have been spent getting a good job or getting ready to hold one.

ENGINEERING IN THE COUNTRY

By Jake O. Altrades

Quite a spell ago I done a good bit o' work on thrashin' engines down country in a little job shop. The main works of the shop was a blacksmith shop and a hand drill mounted on a post, though the sign "Machine and Smith Shop" was somewhat justified by an old 8-in. face lathe with a portable tail rig which most of the time slept peacefully in one corner.

One day thar came in a young fellow and an old farmer with a haulin' engin' to be tinkered up and the biler retubed. They hauled the ancient outfit up alongside the shop and the old man cast loose and drove off tellin' the youngster to stick close an' watch all the fine points so he could "fix the thing next time without no machinists botherin' 'round."

Well, the feller hung around all right and got in the way good an' plenty, takin' up more room in the shop than all the rest of the outfit. He watched right sharp, too, and, questions!—they seemed to come to him by inspiration. But he wasn't seemin' to sense things, quite.

After 2 weeks of off an' on workin' we got the job done an' fired up to test the engin' and biler. Everything worked all right and the farmer drove in and hauled away his property takin' the young chap along as "chief injiner," so he said.

Of course they never tried to start the engine until they had to in a hurry just at thrashin' time. Then they got a water wagon load at the brook, filled the biler, fired 'er up, an' right after dinner they let 'er go. For 2 hr. she run slick as a whistle; then the "injiner" found that the water was disappearin' from his sight glass an' kep' on disappearin' spite of all he could do. He puttered and the farmer sputtered as long as they dared 'til the young feller, who did know enough to get skeered when things went wrong, said, "We got to stop 'er. She may bust!"

So, then they pulled the fire an' let 'er cool down, with all hands, even to the women folks, swearin' mad, and most of 'em, 'cept, of course, the women, swearin' out loud.

Then the old man hitched up a rig and sent his wife up to town to fetch down the "hull shop," an' she certainly give us a settin' out that was a credit to what the old man had taught her.

I wasn't hungry for the job, but the foreman said, "Jake, guess it's up to you," so hustled some piping tools, files, hammers, wrenches and a sundry lot of bolts, rivets and screws, with a few odd nipples and fittings into a bag and got in with the old lady. She was a niceish sort and good natured enough when she wasn't mad, so I jollied along and told stories 'til she thawed out a little; then I tried to pump her about the engine. But she didn't know nothin', only "the pesky thing jest kept losin' water," and got mad when she thought of it. So I give up and enjoyed the scenery and made casual talk on the state of the crops an' the weather.

We got there 'bout supper time, an' all the folks were sittin' around chewin' straws an' still mad clean through. All of 'em wanted to talk at once; but the old man was most in earnest, an' said with considerable emphasis an' then some, "So ye get hyar, did ye? Well, by George, ye'll hev ter stay 'til ye hev her fixed right this time, an' ye don't git a darn cent fer it nuther"; an' ma she said the same.

I knew the outfit was O. K. when she left the shop and 2 hr. of work wouldn't have knocked her out unless somethin' broke, which they would have seen or heard. So I kep' cool an' climbed down an' looked her over, careless like, and said to the young chap, "What seems to ail her?"

He stared at me a minit an' then says, "Great gosh, that's what we want ter know. That's why we sent fer yer. We jest can't git eny water in 'er at all."

Of course, the bug was somewhere in the feedin' arrangements but it was a guess where, for everything looked fust class. I said to myself, "We'll start both ends and run to the middle an' we'll ketch 'er somewhere." So I unscrewed the safety valve—a little pop—an' stuck in a stick. She had water all right; most up to the top of the tubes, so she wasn't leakin' back very fast, an' I filled her up with a pail 'til we could see the water in the glass.

Then I went for the other end an' took off the cap of the suction valve; an' there it was; a young gravel stone wedged under the disk an' holdin' it clear up off the seat, wide open. I took it out on the quiet an' fiddled 'round a little, an' then said, "Oh! I guess she'll go all right."

The old man spoke up right sharp and says, "Young feller, I don't want no guessin' 'bout it, confound ye. I'm too old ter be fooled twice. An' ye hev ter make 'er go!"

So I says to the "injiner,"—"Fire 'er up while I git somethin' ter eat," an' I went up ter the house ter see what ma had been doin'.

She hed, all right, an' she knew how, too. We hed salt pork, pertaters an' hot biscuit, but they was cooked "the way your mother used ter bake," an' I had a hunger like father used ter give me at the woodpile. An' on top fer desert we had apples an' cider. I felt right chipper when I got back to the field with the hull caboodle follerin' on ter see if the balky engine would "git up fer the shop chap." By that time the caboodle took in all the men, boys and girls from 2 miles 'round and a good bunch of the women, so my startin' up looked like a first night theater openin', only all the audience wanted to be on the stage an' help with the job. Besides they wanted ter be sure she would go termorrer, fer all the grain 'round was waitin'.

The boy mechanic had a little steam up when we got there, an' after a little bit we were ready to start. But when I give the word, all hands got ready to clear out, if there was eny sign of trouble.

The young chap turned on steam an', much to his surprise she went off all right, an' the pump went all right, an' the water stayed right up to the mark regardless of the load. Then the old man hed to start 'er a couple of times to make sure that she "reely was all right," an' then he said, "Levi Patrick Jones, you air certainly thick! Ef I hed eny idee you wus so darn dumb, I'd a stayed at thet shop myself an' then I'd a knowed all thar is to thet thar injun."

Then, of course, ma an' the girls had to guy the poor feller a little, an' he was mighty glad to get the outfit shut down for the night, an' to hitch up to drive me home.

I give him a few pointers on the way back about where to look fer trouble, but I don't suppose he remembered them until next time.

I had to ride 15 miles and back and lost half the night's sleep to take a little stone out of a valve, that the farmer's little girl could have done in 10 min. or less. Yet folks wonder when accidents happen to such engines. The real wonder is that half of 'em don't blow up every year.

Questions and Answers

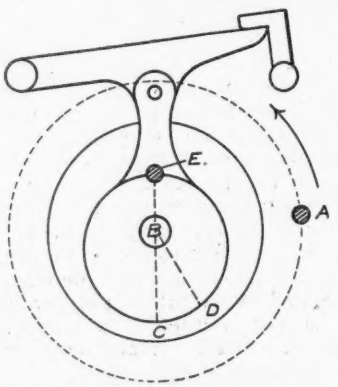
Ask about your troubles—help the other fellow with his. Give your name and address. For a quick answer enclose stamp for reply.

Brown Engine Valves, Injector Action.

1. If the clutch that drives the cam shaft on a Brown engine was designed so it would drive the cam shaft without slipping if it turned in the opposite direction, could not the engine be reversed by changing the cams on the cam shaft instead of changing the bevel gears?

2. If the exhaust cam or upper arm that connects with the exhaust valve stem should slip, and no tram has been made beforehand, can a tram be made from the end that has not slipped, and then set the other end by it?

3. If they are out of position on both ends, can the cylinder head be removed and the valve on the head end be set right, then make a tram and use it for setting the crank end exhaust? This is assuming there are marks on the valve stem connecting to the upper arm showing working edge and lap.



STEAM ECCENTRIC OF BROWN ENGINE; A, CRANK PIN'S RELATIVE POSITION; B, SIDE SHAFT; C, 90-DEG. POSITION OF ECCENTRIC; D, ADVANCED POSITION OF ECCENTRIC AHEAD OF 90 DEG.

4. Why should the cutoff not be later than 7/16 stroke with the governor in its lowest position?

5. Why are Brown engine governors called parabolic governors, and what is the meaning of parabolic?

6. Why does shot put in the balls of a Brown governor increase the speed of the engine? I should think it would have no effect on the height as in a Corliss governor.

7. If an injector is built to force against a high pressure, why will it not handle as much water in proportion to the steam used?

8. If an injector is built to handle a large volume of water, why will it not force against a high pressure?

H. W. C.

A. Because it is necessary for the side shaft on the older design of Brown engines to rotate in such a direction as will turn the top of the side shaft away from the cylinder, when a person stands at the head end of cylinder head looking toward the crank shaft, regardless of the direction of rotation of the crank shaft. This is to obtain the proper opening and closing of the valves at the correct points in the stroke. The method of retaining the same direction of rotation for the side shaft is to change the location of the bevel gear and collar on this shaft.

2. Provided that the valve that has not slipped is properly set, a tram can be made for use on the other exhaust valve setting, and the final adjustment obtained from the indicator diagram as usual.

3. To make a tram for the exhaust valves, remove the cylinder head, and insert a piece of paper into the exhaust port and move the exhaust valve away from the cylinder (the valve moving toward cylinder to open) until it just nips the paper. Then make a gage of sheet metal of such length as to reach from the finished surface or the side of the cylinder casting to the mark on the round eye of the exhaust valve stem farthest from the cylinder which is the opening and closing mark and represents the edge of the port. The gage is then used as usual.

4. An examination of the figure will assist in understanding what determines the latest point of cutoff. The connection between the steam eccentric and the steam valve is a direct connection or motion. The result is that both lap and lead are given the steam valve, when the crank is on the dead center the steam eccentric must be set ahead of the crank more than 90 deg. in the direction of rotation. Let the dotted circle represent the relative path of the crank pin, which we will assume to be at A, and the full circle to represent the path of the steam eccentric.

Position C represents the eccentric at 90 deg. ahead of crank, as a reversing rocker is used; to give lap and lead the eccentric is advanced on the side shaft in the direction of such shaft to the position D. As the steam eccentric lifts the steam valve when moving upward from C to E all opening movement of the valve must occur within that travel of the steam eccentric. Therefore the eccentric reaches the position E about the time the piston has completed ½ of its stroke. Because during the remainder of the revolution of the steam eccentric from E to C the eccentric is traveling in the opposite direction and would close the steam valve if not tripped by the governor.

By giving the steam valve negative lap or lead the range of cutoff can be increased beyond 0.5 stroke.

5. A parabola is a curve formed by cutting the surface of a cone with a plane that is parallel with one of its sides. A parabolic curve is the curve formed by such intersection. The path swept through by some governor balls within the highest and lowest position describes such a curve and some persons at times call such governors parabolic governors. The curve that the balls travel through when the arms of the governor are crossed is something like this.

6. Engines are designed for the governor to rotate

in a certain plane under normal conditions and the centrifugal force developed by the balls in their rotation balances their gravity effect and spring tension. So long as the governor is off the starting pin if weight is added to the governor in the form of shot or weights the gravity overcomes the centrifugal force causing the governor to travel in a lower plane, thereby increasing the cutoff and m.e.p. and thus increasing the speed of the engine.

7. The injector will not deliver the same volume of water per lb. of steam used because the tubes are shaped differently and the discharge end of delivery tube is of a correspondingly smaller area than the entrance in order that the water may obtain a greater velocity to overcome the higher pressure. The pressure on the pushing side is thus increased.

8. Because the proportions of the tubes are not correct for such service. P. E. Merriam.

Converter Ratio; Steam to Melt Ice; Ratio of Expansion

If a 3-phase rotary converter is supplied with alternating current at 345 volts, what will be the e. m. f., at the commutator of the machine?

2. How many pounds of steam at 100 lb. absolute pressure would be required to melt 20 lb. of ice at 24 deg. F.?

3. In a compound engine with a high-pressure cylinder 14 in. diameter, and a low-pressure cylinder 30 in. in diameter, with a 36-in. stroke, the clearance is 5 per cent in each cylinder; if cutoff occurs at ⅓ stroke, what is the total ratio of expansion by volume?

D. O. C.

A.—The direct current voltage of a 3-phase rotary converter is equal to the alternating current voltage divided by 0.612. In your case, therefore, the result becomes $345 \div 0.612 = 563.7$, which should be the voltage across the direct current side of your convertor.

2. Specific heat of ice is 0.504, taking water as 1. Latent heat of freezing = 142 thermal units. Heat required to melt 20 lb. of ice at 32 deg. F. equals $20 \times 142 = 2840$ B. t. u. Heat required to raise 20 lb. of ice from 24 deg. F. to 32 degrees $= 8 \times 0.504 \times 20 = 80.64$ B. t. u. Total heat required to melt the ice equals $2840 + 80.64 = 2920.64$ B. t. u.

One pound of steam at 100 lb. absolute pressure contains 1181.8 B. t. u. above 32 deg. F., according to the steam tables. Therefore the number of pounds of steam required will be $2920.64 \div 1181.8 = 2.471$ lb.

3. The actual ratio of expansion is equal to the cylinder displacement at exhaust plus the clearance in cylinder, divided by the cylinder displacement at cutoff plus the clearance in the high pressure cylinder. Stated in figures for your case this becomes: $\frac{14^2 \times 0.7854 \times 36}{3}$ $= 1846.7$ cu. in. = piston displacement at cutoff; 5 per cent clearance $= 1846.7 \times 3 \times 0.05 = 277$. cu. in. $1846.7 + 277 = 213.7$ cu. in. = volume at cutoff. $30^2 \times 0.7854 \times 36 = 25410$ cu. in. = low-pressure cylinder displacement. 5 per cent clearance $= 25410 \times 0.05 = 1270.50$ cu. in. $25410 + 1270.50 = 26680.5$ cu. in. = volume at exhaust.

$26{,}680.5 \div 2113.7 = 12.7$ = total ratio of expansion by volume.

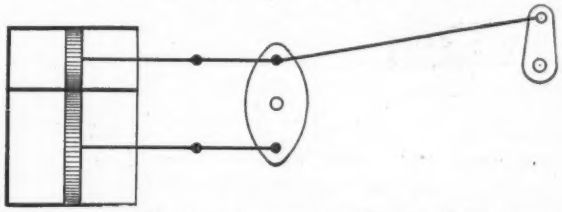
Woodruff and Beach Engine

Some time ago the Woodruff & Beach Engine Co., Hartford, Conn., did a good business in the manufacture of low speed engines, many of which are yet doing good service in factories located in the New England states. I shall be pleased to hear from some engineer who will kindly inform me, through the columns of Practical Engineer, as to the proper methods of valve setting and other peculiarities with regard to this engine. Enquirer.

Quantity of Cylinder Oil Required

Regarding my inquiry which appeared on page 609 of the October issue under the above heading, I wish to make further explanation as to the type of engine, as the article as published may mislead some.

It is a pumping engine and has a high and low-pressure cylinder on right side and a high and low-pressure cylinder on left side. And cylinders on each side are placed one over the other. The high-pressure cylinder is exhausted direct into the low-pressure cylinder. The right hand high and low pressure pistons are connected to one end of crank shaft and the left hand high and low-pressure pistons are connected to the other end of crank shaft. High and low-pressure pistons on both sides are connected to a rocker beam.



ARRANGEMENT OF CYLINDERS AND CONNECTING RODS

with short link rods. The main connecting rod is attached to the upper end of rocker beams and crank, as shown in the illustration. Such an engine is known as the Woolf type, and in my opinion should be termed a twin or doubled compound, as there are 2 high-pressure cylinders and 2 low-pressure cylinders with their pistons connected to 2 separate cranks set at 90 deg.

This engine is built by the Holly Manufacturing Co. of Lockport, N. Y. Its maximum speed is 18 r. p. m., and I have run it as low as an average of 4 r. p. m. for 24 hr. I will state that valuable information on the Woolf type of engine can be found on page 762 in Kent's Mechanical Engineers' Pocketbook. The average speed of our engine is about 8 r. p. m.

L. W. V.

Telephone Troubles

1. What are the first things to be looked after if a telephone line is struck by lightning and some of the telephones are burned out? Stromberg-Carlson and Western telephones are used.

2. What is the cause of broken speech in a telephone, that is in the hearing? You can hear a few syllables but can not understand anything. Is the trouble in the receiver or in the line and how can it be remedied?

A. 1. First test to be sure that the instrument is burned out, if it is, the trouble will most likely be found in the induction coil on the ringers. The burned out coils and fuse should be replaced, and the open spark lightning arrester cleaned as the cause of the burn out is due to defective arrester.

2. Broken speech in a telephone is caused most frequently by a loose receiver cord tip, or it may be a shattered cord that causes the trouble. The cause is inevitably a loose connection somewhere which, when remedied, will clear the difficulty.

Temperature of Cooling Water

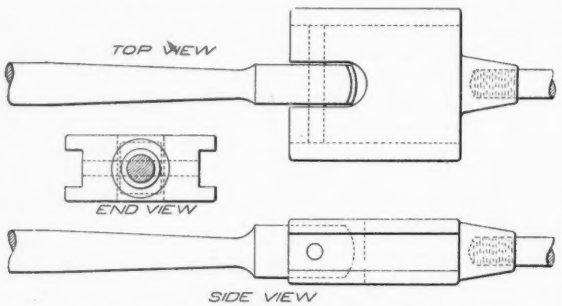
I am operating a 500-hp. twin-tandem gas engine. I would like to hear from engineers operating this type of engine who use the jacket cooling water over and over, what kind of a cooling system they have?

We have a home-made cooling system here, and it does not work just right as yet. I would also like to know at what temperature they run the water in the cylinder jacket piston, exhaust valve and packing cage.

E. D. M.

Design of Engine Bed

Through the columns of your paper I would like to be informed about designing an engine bed for 2 small model engines to run together, one left and one right. I have two cylinders, size 1.5 by 3 in., and all connections finished; they are designed according to standard methods. The engines are of the slide valve type, intended to develop 0.5 hp. each.



VIEWS OF HORIZONTAL CROSSHEAD

The crossheads are horizontal instead of vertical and this is the main difficulty in designing the frame. Perhaps some of Practical Engineer readers could tell me about how to do this.

H. L. W.

General Power Plant Questions

1. Give 3 important reasons for the use of feed water heater.
2. Why do the return pipes hammer when turning on steam?
3. Why does soft coal smoke and why not hard coal?
4. What determines the proper area of safety valve?
5. What is the difference between duplex double acting and single acting pumps?
6. Will moving an eccentric half-way round change the engine from running over to running under and will it affect the distribution of steam?
7. How much indirect heating surface is required for a school in this latitude?
8. Give 3 reasons why cast iron is used for grate bars.
9. What effect would it have if you decrease valve travel?
10. How would you test a crown sheet for blisters?
11. How is an indicator piston packed?
12. What is a fusible plug? Where is it located? What is it made of?

J. P. F.

A. 1. You will find the answer to this question in our January, 1909, issue, Pages 31 and 45.

2. Return pipes hammer when turning on steam because there is water collected in them. This water is forced along by the steam in slugs, and the steam coming in contact with the cooler water is condensed, giving the same cracking and pounding sound that you find when a jet of steam is turned into a barrel of cold water.

3. The smoke from soft coal is caused by the volatile matter driven off by heat. Coal is made up of compounds of carbon and hydrogen. Some of these evaporate or turn into vapor at a low temperature, some at a high temperature. In the hard coal there are practically none of the compounds which will be driven off at a low temperature, so that there is no smoke made. In the soft coal a considerable part of it is made up of the compounds which are driven off at a low temperature and temperature so low that these compounds will not burn but will be thrown out in the form of smoke.

4. You will find discussion of this question on Page 251 of the April issue.

5. The duplex pump has 2 sets of steam cylinders and 2 sets of water cylinders. The steam valve of 1 side is moved by the piston rod of the other side, and vice versa. The single cylinder pump has only one steam and one water cylinder, and the steam valve is moved by a pilot piston, the action being too complicated for brief explanation. A double-acting pump is one which works on both sides of the piston. The single-acting works only on one side.

6. You will find the answer to this question in the May issue, given by Mr. Browning on Page 308.

7. This question is answered on Page 255 of the April issue.

8. Cast iron is used for grate bars because it is cheap, because it can readily be formed into the shape required for grates, and because under a high heat it is less likely to bend and sag than wrought iron.

9. This question is also answered in the May issue by Mr. Browning.

10. A blister is the cracking up of a part of the surface of a boiler plate and the way to test a crown sheet for it is to examine the crown sheet carefully all over for any raised spots, and if any are discovered to test this with a hammer and cold chisel to see if there is a splitting off of the outer surface from the rest of the plate.

11. An indicator piston is packed by the turning of grooves in the piston, which fill with water from the condensed steam.

12. A fusible plug is made of some alloy having a low melting point and so placed that when the water gets low in a boiler this plug will melt out and let the water out on to the fire, calling attention to the low water condition.

Throw of Eccentric

If you have a 16-in. eccentric with a 2-in. throw and should turn it down to 15 in., what effect would it have on the travel of the valve?

A. S.

A.—The travel of the valve is dependent upon the distance between the center of the shaft and the center of the eccentric regardless of the diameter of the eccentric. Therefore, if a 16-in. eccentric with a 2-in. throw should be turned down to 15-in. without changing the position of its center the travel of the valve would not be affected in the least.

A NOVELTY IN MARINE CONSTRUCTION is the Yacht Winchester, being built by Yarrow, which will have water-tube boilers fired with oil fuel. The engines will be Parsons turbines of 2,400 hp. driving 3 single propeller shafts. The vessel is of 180 tons burden, 160 ft. long, 15 ft. 6 in. beam, 9 ft. 9 in. deep.

ANSWERS TO QUESTIONS FOR HOISTING ENGINEERS.

August Issue, Page 491.

By W. E. Merrill

ANSWERS to Questions 1, 2, 3 and 4 will be found in October, 1908, Page 48, and also in the summary of laws given by Andrew Flesher in another part of this issue.

5. The indicated horsepower of an engine is the power as figured from the indicator card and the data needed are the mean effecitve pressure, which is found from the card as shown in the article in this issue on Rating of an Engine, the length of the stroke expressed in feet, area of the piston in square inches, and the number of working strokes per minute. Sometimes the length of the stroke in feet multiplied by the working strokes per minute is taken as one factor and called the "piston speed" in feet per minute. Thus for an engine with 60 lb. m. e. p., 10 in. diameter and 20 in. stroke at 100 r. p. m., we have, indicated horsepower $= \frac{60 \times 1\frac{2}{3} \times 78.54 \times 200}{33{,}000}$, which gives 44.26 as the indicated horsepower.

6. For a plant using 1200 lb. of coal in 8 hr., with feed water at 45 deg., if the feed water were heated to 100 deg., the difference would be 55 deg. gain, and assuming that 1 lb. of coal will evaporate 10 lb. water, 1200 lb. coal will evaporate 12,000 lbs. water. Saving 55 B. t. u. per pound on 12,000 lb. gives $55 \times 12{,}000 =$ 660,000 B. t. u., and if a pound of coal averages 13,500 B. t. u., 1200 lb. would have 16,200,000; 16,20,000 — 660,000 leaves 15,540,000 B. t. u., which at 13,500 per lb. gives 1151 lb. of coal.

7. The first thing to do in preparing a boiler for cleaning is to let the fire die out and cool the boiler down. It should take all night to cool a boiler down, the boiler to be pumped up 3 gauges and left standing 3 or 4 hr., then blown down. This operation repeated 3 or 4 times a night will cool a boiler down so it can be cleaned the following day. Take off the front manhole plate, (horizontal boiler), or top manhole plate (if vertical boiler) and wash boiler with warm water if a tubular boiler. If boiler is very scaly get in the boiler and scrape off scale. If boiler is water-tube, take off both hand plates from all tubes and use either air or water turbine to cut scale off tubes. Blowoff and mud drum plate to be taken off while the boiler is being cleaned. When the boiler is cleaned, put on new gaskets where needed, mud drum plate, hand plates of tubes (if water-tube) and manhole plate and fill with water.

8. For a tank 10 ft. in diameter at the top, 12 ft. in diameter at the bottom and 12 ft. high, the water contained in cubic feet will be found by the following rule: Square the top diameter, square the bottom diameter, multiply the top diameter by the bottom diameter; add these 3 products together, then multiply by the height of the tank and by the constant 0.2618. The result will be the contents in cubic feet. This gives $10^2 = 100$; $12^2 = 144$; $10 \times 12 = 120$; the sum of these is 364, multiplied by 12 and by $0.2618 = 1145.5$ cu. ft. At 62.5 lb. per cu. ft. this gives 71,468.7 lb. A standard boiler horsepower is 30 lb. of water per hour from a feed-water temperature of 100 deg. and at 70 lb. gage pressure. If a plant is using 234 h.p., $30 \times 234 = 7020$ lb. used per . .r, and $71{,}468.7 \div 7{,}020$ gives 10.18 hours, or 10 hours and 12 minutes as the time that the water would last.

9. The thickness of steel in the boiler has no bearing on the thickness in the pipe, as they are different diameters, but, if the pipe is 22 in. diameter and will carry 150 lb. pressure and is made of steel having a tensile strength of 60,000 lb. a sq. in., then the thickness will be equal to the pressure times the radius in inches times the factor of safety, divided by 60,000, or, in this case, $150 \times 11 \times 6$, (6 being taken as the factor of safety), $\div 60{,}000 = 0.165$ in. or nearly 11/64.

10. For a tubular boiler 72 in. in diameter, 16 ft. long, to give 100 hp., we would assume 12 sq. ft. heating surface to the horsepower. Then the area of half the shell is heating surface and this will be $3.1416 \times 16 \times 6 \div 2 = 150.7$ sq. ft. Also half the back head is taken as heating surface and this will be $0.7854 \times 6^2 \div 2 = 14.14$. The sum of these two is 164.8. The total heating surface required is $100 \times 12 = 1{,}200$ sq. ft. Subtracting 164.8 leaves 1,035.2, the surface to be furnished by tubes. For a 3.5-in. tube there will be 1 sq. ft. of outside heating surface for a length of 1.091 ft. A 16-ft. tube will then have $16 \div 1.091 = 14.67$ sq. ft. of heating surface, and $1035.2 \div 14.67$ gives 70.5 or 71 as the number of tubes required.

If the ratio of heating surface to grate be taken as 35 to 1, the grate surface required will be $1200 \div 35 =$ 34.3 sq. ft., and if the rough rule be taken of 3 sq. ft. of grate surface to 1 sq. in. of safety valve, we shall have $34.3 \div 3 = 11.45$ sq. in. as the area of the safety valve, which calls for a 4-in. valve. This should be of the spring loaded pop type.

11. With a pair of compound engines at 150 lb. steam pressure and high-pressure cylinder 18 by 20 in. running noncondensing, the ratio of cylinder volumes would be about 3 to 1. For a condensing engine it would be 4 to 1. Given the same length of stroke and assuming 3 to 1 ratio, the diameter of the low-pressure would be $\sqrt{3} \times 18$ in. $= 1.73 \times 18 = 31.5$ in. This would probably be made a 30-in. cylinder, letting the cylinder ratio vary to this extent.

12. For a circular tank 10 ft. diameter at the top, 12 ft. at the bottom and 12 ft. high, the contents will be the same as for Example 8, viz., 71,468.7 lb. No temperature is given in the question and 45 deg., the average temperature of water, will be assumed. To raise this water to boiling point will take $212 - 45 =$ 167 B. t. u., and to evaporate the water at atmospheric pressure will take 966 B. t. u. per pound or a total required of $966 + 167 = 1133$ B. t. u. for each pound. A pound of coal has 13,500 B. t. u. and $13{,}500 \div 1133 =$ 11.81 lb. of water evaporated per pound of coal, and dividing 71,468.7 by 11.81 gives 6051.5 lb. of coal needed.

13. The cylinder of boiler steel 48 in. diameter, 18 ft. long and 0.045 in. thick, will have circumference of 3.1416×4 ft., and this multiplied by 18 ft., the length, gives 226.2 sq. ft. of surface in the shell. For the heads the surface is $4^2 \times 0.7854 \times 2 = 25.13$ sq. ft. The sum of these would be 251.3. The thickness in feet is $0.045 \div 12 = 0.00375$ ft., which multiplied by 251.3 gives 0.42 cu. ft. The weight of 1 cu. ft. of steel is 480 lb. The weight of the cylinder will then be $480 \times 0.942 =$ 452.16 lb.

14. This question is rather blind and does not seem as if properly stated. A drum 6 ft. in diameter would take up 18.84 ft. of rope at each revolution and for a lift of 300 ft. it would require 16 revolutions to lift the cage. The law states that cages carrying men shall not be lifted or lowered at a greater speed than 600 ft. a minute. In this case the cage could be raised in one-half minute or the speed of the drum would be 32 revolutions a minute.

NEWS NOTES

EDWARD C. BROWN, who is manager for the Dearborn Drug & Chemical Works in the Hawaiian Islands and the Orient, has been elected president of the Commercial Club of Honolulu. This club is similar to the chamber of commerce and association of commerce organizations in the large cities of the states. This is an honor highly esteemed, and is an evidence of the high standing of the Dearborn company's representative in the Hawaiian Islands. Mr. and Mrs. Brown recently made a trip in the interests of the Dearborn company to the Orient, spending several months in China, Japan, Korea and the Philippines.

W. L. LOVELAND of the Allis-Chalmers Co., with which he has been associated for the past 19 yr., and, since 1904, manager of their mining machinery department, has accepted a position with the Mine & Smelter Supply Co. as their general manager. H. C. Holthoff, for many years identified with the mining branch of the Allis-Chalmers Co. and for the past 2 yr. manager of their Mexico office, will succeed Mr. Loveland as manager of the mining machinery department of the Allis-Chalmers Co. and be located in Milwaukee. Mr. Holthoff arrived in Milwaukee about October 15.

C. A. POE, well known in steam practice circles in Pittsburg and adjacent territory, has disposed of his interests in that city and accepted a position with the Wright Manufacturing and Austin Separator Cos., of Detroit, Mich., in charge of the mechanical department, succeeding H. H. Humphrey, deceased.

MAY TO JULY, 1910, an American Exposition will be held in Berlin, Germany, under the lead of a committee of representative business men of the United States. American products only will be shown with the object of strengthening their prestige abroad. John M. Carson, chief of the Bureau of Manufactures, 50 Church St., N. Y., is prepared to answer all inquiries and give further information.

KEUFFEL & ESSER CO., of Hoboken, N. J., has been awarded the Grand Prize at the Alaska-Yukon-Pacific Exposition on all its line of drawing materials, mathematical and surveying instruments and measuring tapes.

ANOTHER VERY SUBSTANTIAL and commodious building is to be added to the Niagara Falls, Ont., branch works of the International Acheson Graphite Co. The structure is to be 50 ft. wide by 105 ft. long, and the contract has been awarded to W. S. Homan, of Niagara Falls, Ont. The facilities afforded by this addition will make the Canadian works of the Graphite Company quite complete in its ability to care for a rapidly growing trade, made so by Canada's industrial growth. The building will contain a new grinding plant, in which the lubricating, electrotype and other grades of powdered graphite will be prepared for market. It will also contain a stock room for package goods, such as graphited greases, powders, etc., while a new shipping room will make it most convenient for promptly filling orders.

THE FACTORY AND ASSETS of the Weber Gas Engine Co., formerly of Kansas City, have been purchased by the Sheffield Gas Power Co., of the same city. This company will continue the manufacture of Weber Gas Engines and Producers, the sales and factory departments being in entirely new hands. George M. Hawes, president of the company, is a graduate of Massachusetts Institute of Technology, who has been interested in machinery and electrical work for a number of years, giving particular attention to central station power plants.

Freeman Field, vice-president and treasurer, has been for the past 12 yr. exclusively in the gas engine business, both in manufacturing and selling. For the past 7 yr. he has been connected with the Olds Gas Power Co. as general sales manager and western manager.

W. H. Spiller, assistant manager of the new company, studied electrical and mechanical engineering at Harvard and Brown Universities, and has had thorough experience in the installation of both steam and gas power plants. For the past 6 yr. he has been engaged with gas power interests, in selling and manufacturing, and is well fitted to see that all details of construction are carried out with care and precision.

THE CHAPMAN VALVE MANUFACTURING CO., of Springfield, Mass., has recently been reorganized, and a new management is now at the head of the company. Adolph W. Gilbert is the new president and general manager, and for 12 yr. has been known in the valve world for good management and producing good goods.

Robert Shirley will be the new works manager and engineer, and comes to the company with 15 yr.'s experience in designing valves, among them the largest valves ever made, weighing 126,000 lb., and with a 9-ft. opening. Edward O. Davis and John Busch, who are well known in the valve field, are also to be associated with the company.

The department of assembling and testing of valves and hydrants has been made independent of all other departments of the factory and placed in charge of a man who is responsible directly to President Gilbert, a policy which has been successfully pursued by Mr. Gilbert for the past 8 yr.

L. G. KIBBE HAS RESIGNED as treasurer of the Wheeler Condenser & Engineering Co., of Carteret, N. J., in order to take an active part in the management of the Warren Steam Pump Co. of Warren, Mass. Mr. Kibbe will be located at the head offices of the latter company at Warren.

THE UNITED STATES CIVIL SERVICE COMMISSION announces an examination on November 24, 1909, to secure eligibles to fill a vacancy in the position of miller and engineer, qualified to operate a sawmill, $900 per annum, Uintah and Ouray Indian Agency, Utah.

The examination will consist of the subjects mentioned below which count as indicated: Practical questions (covering installation, repair and operation of boilers and steam engines and pumps), 40 per cent; experience in handling steam engines and boilers and pumps (rated on application), 20 per cent; experience and qualifications as saw miller (rated on application), 40 per cent.

The age limit is 20 yr. or over on the date of the examination, and further information can be had by applying to the Commission for the announcement No. 589.

IN THE EVENING SESSION Technical Courses at Lewis Institute for 1909-10, which opened to the public on Oct. 4 and will continue until May 19, instruction is given in engineering principles and engineering mathematics, including Mechanics and Heat, Electricity, Laboratory Work, Electrical Instruments, Motors and Generators, Transformers and Transmission, Steam Engines, Gas Engines, Steel and Concrete Construction, Elementary Drawing and Details of Machinery, Piping and Pumps, Machine Shop Practice and the use of machine tools, and a course in the Principles and Practice of Chemistry. Full outline of these courses may be obtained by application to the Secretary of Lewis Institute, Chicago, Ill.

AT THE NEW YORK NOVEMBER MEETING of The American Society of Mechanical Engineers, to be held on the 9th in the Engineering Societies Building, 29 West 39th St., at 8:15 o'clock, there will be 2 papers presented. One by Professor Gaetano Lanza and Lawrence S. Smith of the Massachusetts Institute of Technology, on Reinforced

Concrete Beams, and the other by Professor Walter Rautenstrauch of Columbia University, on Stresses in Curved Machine Members.

The paper on Reinforced Concrete Beams is the same as that given at the Boston meeting of the society on Oct. 20. It compares the results of tests upon full sized beams made at the Massachusetts Institute of Technology and the University of Illinois with 3 different theories of beams of this type.

The paper on Stresses in Curved Machine Members outlines the method of procedure for the design of principal sections of hooks, punch and shear frames and other curved machine parts. Experimental results are submitted in support of the theory presented.

ANNOUNCEMENT HAS BEEN MADE by the United States Civil Service Commission of an examination to be held on November 22-23-24, 1909, to secure eligibles to fill a vacancy in the position of skilled draftsman (experienced in instrument work) at the Frankford Arsenal, Philadelphia, Pa., at $1,400 per annum. The examination will consist of the following subjects, weighted as indicated: Mathematics (comprising arithmetic, algebra to quadratics, geometry, mensuration, logarithms, use of tables, elementary problems in mechanics, and use of slide rule), 15 per cent; materials (comprising all the materials used in machine construction), 15 per cent; practical calculations (involving the interpretation of formulas and the correct working out of results for special cases), 20 per cent; drafting (involving competent knowledge of machine construction and the ability to draw neatly to a scale), 25 per cent; training and experience, 25 per cent. The age limit is 18 yr. or over on the date of examination. Those interested should apply to the Commission for announcement sheet 587.

ON NOV. 1 the New York Office of the American Goetze Gasket & Packing Co., will be moved to New Brunswick, N. J., where a large tract of land has been purchased and a factory will be erected to manufacture Goetze's Gaskets and Goetze's Metallic Packing.

ON OCT. 13 A RECEPTION was tendered to National President Wm. J. Reynolds, by the Hoboken Association, No. 5, N. A. S. E. of New Jersey, at I. O. O. F. Hall.

After dinner oratory was the order of the evening and President Snook of No. 5 welcomed the large assembly, and told the story of No. 5, and expressed the appreciation of the association for the great honor conferred by electing one of its members as national president.

Herbert E. Stone, past national president and eastern representative of the Dearborn Drug and Chemical Works, acted as toastmaster and introduced the speakers, as follows: Past National President, Joseph F. Carney; Past National Secretary, Wm. H. Cronley; Secretary-Treasurer Life and Accident Department, J. Douglas Taylor; Past National President, R. O. Smith; New York State Deputy, James F. Coe; Past National President, Wm. T. Wheeler; Magistrate of City Court, Judge McGovern; New Jersey State Deputy, J. J. Reddy; President of New York No. 25, L. S. Everson; Past State President of New Jersey, John J. Callahan; President of the National Exhibitors' Association, Wm. G. LeCompte; and National President Wm. J. Reynolds, who received a long ovation with cheers and "What's the matters with Reynolds?"

Interspersed with the speaking was music by a 5-piece musical body brought in by Brothers Wheeler and Reilly, and known as the Dearborn Cast Iron Band. Although the music was said to be not as bad when written as it sounded, the feature added much to the enjoyment of the evening. Others contributing to the entertainment of the evening were Herbert Self of the Peerless Rubber Co., Billy Murray of Jenkins Bros., Frank Corbett of the Ashton Valve Co., Johnny Forsman, Joe McKenna, and Jack Armour of the Hill Publishing Co.

CARL S. PEARSE

The newly elected vice-president of the N. A. S. E. started in the business of stationary engineering some 20 yr. ago in the San Juan Mining District and after a few years concluded that he could make his bread and butter easier in a larger city, so moved to Denver,

CARL S. PEARSE, VICE-PRESIDENT N. A. S. E.

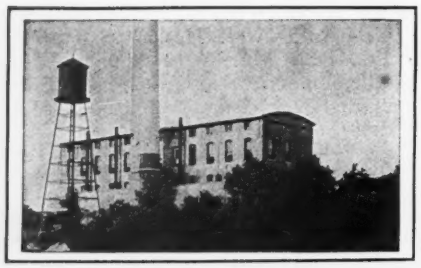
where he had no difficulty in securing a position with the Denver Gas & Electric Co., at its East Side station.

After working there some time he resigned his position to take charge of the mechanical end of the County Hospital as chief engineer, where he stayed until the old longing for the mountains came upon him, and he pulled stakes and started back for the mining district in Breckenridge. There he located on one of the largest dredges in the country searching in one of the mountain streams for gold, but after a few months tired of this, as the other fellows were getting the biggest part of the gold, while Pearse was doing all the work, and the proportion did not seem fair.

He, therefore, returned to Denver and located with the Bimetallic Investment Co., as the superintendent and chief engineer of all its buildings. This position which is a most responsible one and which pays good salary, he still holds.

He has always been active in the Denver Association and in the Colorado State Association. At the Niagara Falls Convention it was his steadiness which kept the wild west bunch together and succeeded in landing the convention at Denver in 1908. After getting the convention there, as chairman of the Entertainment Committee, Mr. Pearse once more proved his ability as a leader, by more than making good every promise that was given at Niagara Falls.

It was not his own notion to run for the office of vice-president at the Columbus Convention, but his friends in Denver, believing that he had well earned the honor and had proved beyond all question his ability to be of great service as vice-president and president of the National Association, carried on the campaign in his behalf, and they, with his great following of friends throughout the country secured for him the election. The photograph published herewith is testimony enough as to the ability and steadiness of purpose which have carried Mr. Pearse from one success to another throughout his engineering career.



Power Apparatus

In Shop and Market

New Ideas in Making, Buying and Selling

COSTS, PRICES AND POLICIES*

By D. K. Swartwout

SOME dealers and their buyers spend valuable time in attempting to tell the manufacturer how much it costs to make his goods. The dealer should not be concerned about costs—he should study quality; what profit he can make on the goods, and the best methods of distribution. As a matter of fact there is no such thing as high price and low price; it is high quality and low quality. No manufacturer, however large and influential, can fix and maintain a high price. In order to have wide distribution and stability, he must fix a fair price. A fair price to the user is based upon a fair cost including a fair wage to the labor making it, a fair return to the capital invested and a fair profit to the dealer.

This brings up the question of a fixed resale price, the lack of which is one of the greatest disturbing factors in our relations with the dealer. The manufacturer is the only one who can fix a fair resale price—and a fair, uniform price will never prevail until the manufacturer assumes that responsibility. If the manufacturer permits his agents to fix his prices and his policies, he has as many prices and policies as he has agents. If the manufacturer fixes the price and the policy, whether it is right or wrong, it is uniform and it is better to have a uniform bad condition, than to have it bad in spots, for it can be more easily detected and corrected.

It is just as important, in my judgment, to have a fixed price to all dealers as to have a fixed price to all consumers; to give a dealer in Pittsburg 10 per cent or any per cent better price than the dealer in Columbus, O., because he buys in larger quantities, is wrong in principle and I will tell you why. The dealer in Columbus may give you the most loyal representation, but on account of a more limited demand he cannot sell enough in quantity to get the extra 10 per cent that you allow the Pittsburg dealer. As the Pittsburg dealer also sends salesmen into Columbus territory, you are giving him the opportunity to sell at the Columbus dealers' cost and still make a profit. If the quantity price must be made, make the quantity so small that the loyal dealer in the small town can take advantage of it.

There are but 2 elements in business: First, men; second, materials. Men are divided into superior men, just-as-good men and inferior men; and materials can be divided into superior materials, just-as-good materials, and inferior materials.

Now superior men and superior materials will conquer the world.

Superior men are handicapped in making or handling inferior materials, and inferior men cannot produce the results by handling or making superior materials. Two grades of materials cannot be made successfully in the same shop. A workman trained to make good things will not make inferior things, and if he has been trained to make things in a slipshod manner his products will not bear the stamp of quality.

The opportunity of this American Supply and Machinery Manufacturers' Association, as I see it, is along these lines. To use our influence to create better methods among the jobbers in the sale of our products. To send among them the most experienced and skilful salesmen we can secure; clean, intelligent, alert and progressive business men, whose example the dealer and his salesmen will emulate. To urge the dealer to carry fewer lines and represent them better, and to devote more time to the training of men.

Now if this organization stands for all that is good in business; lays its plans and works for ideals; conducts its affairs along broad liberal lines; avoids legal entanglements incident to the false idea of the maintenance of prices, except from costs; uses every effort to promote the general welfare of its members along legitimate lines; that, in itself, is the greatest incentive to an increase in its membership.

In conclusion, I earnestly, yet kindly, call attention to the inherent weakness of all organizations, the dearth of competent, reliable, industrious and clean men.

The fall of ancient Rome was directly traceable to the weakness of her citizens as the result of over indulgence, intemperance and licentiousness. This is the age of commercialism where the dollar is placed above the man. If our republic shall endure and grow in strength and usefulness it must be followed by an age of men. We cannot begin too soon.

What constitutes a state?
Not high-raised battlements or labored mound,
Not cities proud, with spires and turrets crowned;
Not bays and broad-arm ports,
Where, laughing at the storm, rich navies ride;

Not starred and spangled courts,
Where low-browed baseness wafts perfume to pride.
No! Men—high-minded men—
With powers as far above dull brutes endued,
In forest, brake or den,
As beasts excel cold rocks and brambles rude;

Men, who their duties know,
But know their rights, and knowing, dare maintain,
Prevent the long-aimed blow,
And crush the tyrant while they rend the chain.

These constitute a state;
And sovereign law, that state's collected will,
O'er thrones and globes elate,
Sits empress, crowning good, repressing ill.

*From an address read before a joint meeting of the American Supply and Machinery Manufacturers' Association with the National Supply and Machinery Dealers' Association.

THE DODGE MANUFACTURING CO. AND ITS PRESIDENT

An interesting story of the founding and development of the Dodge Mfg. Co. was that told in a series of paintings arranged on floats and used in a recent industrial parade at Mishawaka, Ind., the home of the company.

There was a picture of the cradle of the company way back in '78, when in a little frame shop woodenware was made and sold to dealers in that section. Then followed paintings showing the destruction of the factory in '79, and the workmen busy on the foundation for a new and larger structure nearby while the embers were yet smoking, and the birth of the Independence wood split pulley; the Dodge American system of rope transmission introduced in 1883, following the granting of letters patent for the wood split pulley; the addition of iron goods in 1890, when the Dodge idea—standardization and interchangeability—was applied to iron split pulleys, hangers, friction clutches, etc., and finally the plant today, a mammoth industry covering almost 85 acres of ground and manufacturing everything for the mechanical transmission of power, elevating and conveying machinery and the Eureka water softener and purifier.

Wallace H. Dodge, founder of the Dodge company, died in 1894, after his dream of pulleys with standard bores and interchangeable bushings to fit all sizes of shafting; stocks carried in all the manufacturing centers of the world and a factory employing hundreds of men, had been realized, but with the country in the midst of a panic. Black clouds hung over thousands of concerns, and it was in this trying period that Melville W. Mix was made president and general manager of the Dodge corporation. He had been the Chicago manager and later the sales manager and was only 28 yr. old when he assumed his new responsibility. The company came out in 1898 with colors flying, the capitalization later being increased from $250,000 to $1,000,000, with a large surplus today.

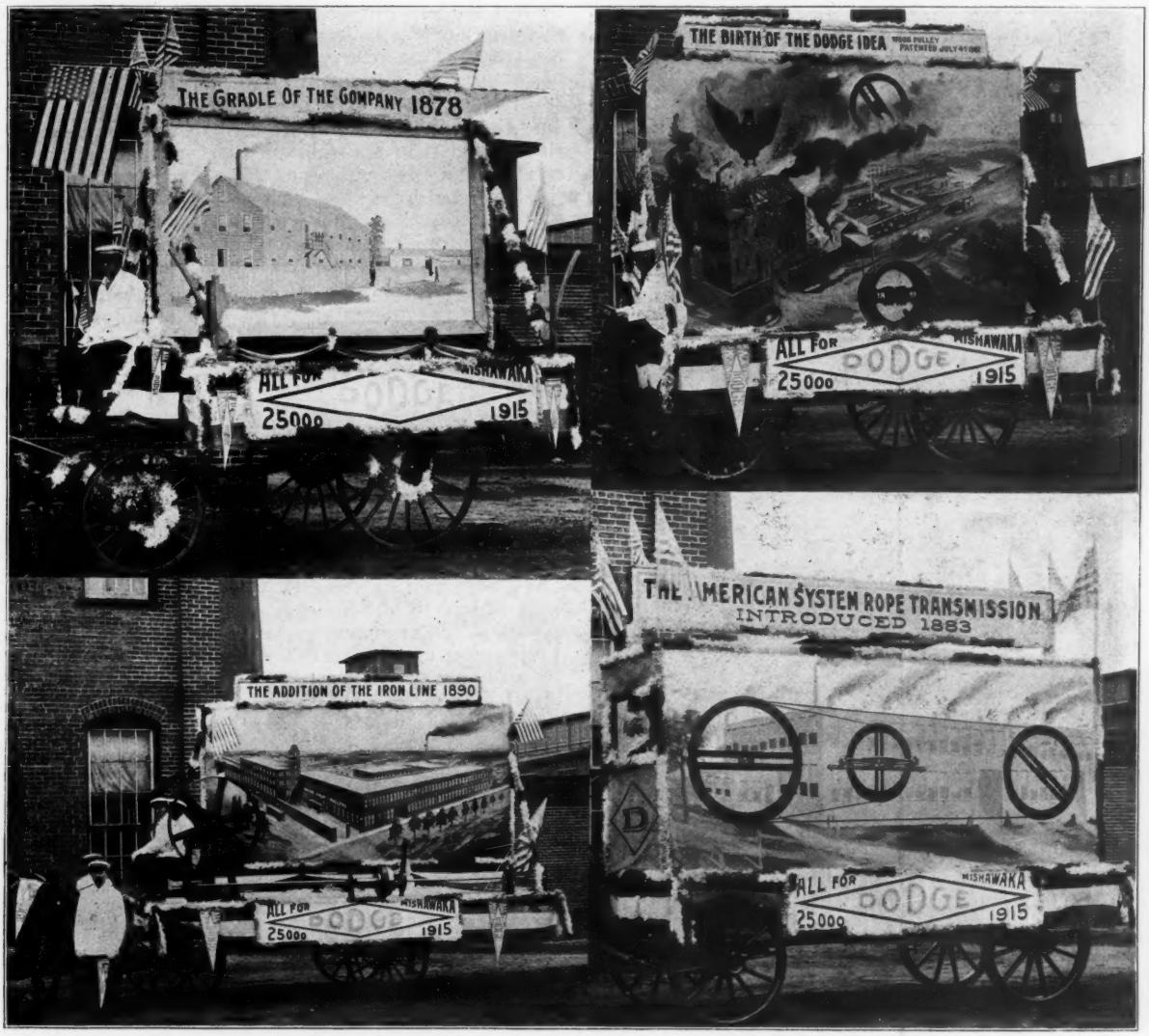


FIG. I. FOUR OF THE FLOATS IN THE DODGE PARADE

Mr. Mix, possessing the staying qualities requisite to win and a believer in prolific advertising, has seen the Dodge Manufacturing Co. grow until its name is known in all the markets of the earth. He is made

of the stock that pushes ahead and holds the respect, the confidence and good wishes of his fellow men.

Not content with scaling the heights and perching on the top in the manufacture of machinery for the transmission of power, Mr. Mix has been successful in other lines. He is president of the National Veneer Products Co., makers of the Indestructo trunks; president of the Mishawaka Trust and Savings Co., one of the leading financial institutions of northern Indiana; president of the Mishawaka Public Improvement Corporation, owners of the new $100,000 Hotel Mishawaka; a director in the Simplex Motor Car Co., and a stockholder in several other industrial and commercial enterprises.

FIG. 2. MELVILLE W. MIX, PRESIDENT AND GENERAL MANAGER OF THE DODGE MFG. CO.

Mr. Mix is treasurer of the Manufacturers' Bureau of Indiana, and was president of the American Supply and Machinery Manufacturers' Assn. in 1908. He has always taken a lively interest in politics and for 2 terms was mayor of Mishawaka, accomplishing much for the city's good.

BAD TEMPER IS A DISEASE and no one is more unfortunate than the man with a constant grouch. For a customer's bad temper, be patient with him.

Don't wait for luck or opportunity to overtake you; keep hustling.

Whatever comes, there is something in it which can be made to add value to your stock of experience.

Always carry out your agreements, and you will eventually make firm business friends.

It isn't so disastrous to fall upstairs as it is down; keep your eye on the next step above you, and keep a climbing.—From the Sawyer Belting Booster.

HOW TO GET BUSINESS

Advertising and selling go hand in hand. Every salesman is a walking advertisement; he carries your message and spreads it by word of mouth. Every advertising effort is an effort aimed at increasing your sales. The question then resolves itself into what sort of aid and how much aid your selling force should have.

A good solicitor prefers not to work without the aid of advertising literature, and advertising literature produces the best results when it is planned and distributed with the knowledge, approval and co-operation of the solicitor. Advertising that does not meet the views of the solicitor has a tendency to dampen his ardor. That over which he becomes enthusiastic has a strong tendency towards increasing his efforts and making him a better salesman.

"Follow up" is an expression that is more extensively used than appreciated. The suggestion that it carries with it is a vital one. No advertising can reach the highest degree of success unless it is followed up by something to stimulate the interest that it arouses, unless it provides a definite plan for turning inquiries into prospects and prospects into customers.

Advertising should be governed by the sales department, and the talk that is handed out on paper should not differ in substance from the verbal selling talk. The printed matter should back up the solicitor's arguments and the solicitor should back up his arguments. A salesman who has a single line of glib talk for everybody, regardless of the attitude of the individual, his prejudices and idiosyncrasies, is a mighty poor salesman. To become a good salesman he must become a student of human nature, he must learn to size up his man and to govern his talk accordingly. The salesman must possess versatility of argument and be ever on the watch for pointers for future use. The knowledge that he acquires of how best to present the proposition to different types of individuals, what points of his argument prove most effective, how his proposition appeals to this one and that one, should be made use of in advertising. It should be tabulated and boiled down until the advertising represents the essence of the varied experiences of the sales force.—Southern Electrician.

GOOD AD. COPY

Some copy as you read it convinces you that the thing advertised is the best ever, and is just what you need. You have read such, and also other kinds. One secret of this is the spirit of the man who wrote the ad., as is well put in these extracts:

"Your advertising must deal with the human will, which in a great many cases, is the human won't.

"It is hard enough even in a personal interview to bend the will of another to your own in a business matter. It is a good deal harder to do it by cold type; but enthusiasm will accomplish it.

"As a matter of fact, nothing very great ever has been or ever can be accomplished without enthusiasm somewhere on the part of somebody.

"As a word, enthusiasm means divine inspiration. Practically it means progress because it is a contagious spirit that rallies to its aid the forces of human nature.

"Every great idea in the history of mankind has had enthusiasm back of it.

"If you want the readers of your advertising to do as you suggest, you must win their co-operation by kindling in them some of your own enthusiasm."

VALVE TOOLS

There is perhaps no one piece of apparatus which gives an engineer more trouble than leaking steam and water valves in his pipe lines. Recognizing this, James McCrea & Co. has recently placed upon the market 2 new appliances which are designed to make valves more serviceable.

The Skinner valve-reseating tools are operated by using the bonnet of the valve in which is placed a taper bushing, for a guide at the top and in the opening of the valve at the bottom is placed another guide, thus insuring perfect alignment. The cutters embody the principle of a shear cut, with ample clearance, for both flat and taper seats, and do not chatter while being used. As the tool does not grind but cuts the seat, it leaves a smooth polished surface. It requires but little pressure to operate the tools and the same valve seat may be reseated many times. These tools will be of value in any power plant where globe and angle valves are used.

The other appliance is the Perfect valve disk, which is interchangeable with composition disks on Jenkins' or Fairbanks' valves. This disk is made of brass which is softer than the seat metal and will withstand the highest pressure. Disks for flat surfaces are corrugated or water grooved and will outwear any composition disks, but to parties who have the use of valve-reseating tools a taper cut on the flat seat of the valve is recommended, as this will give longer life to the valve.

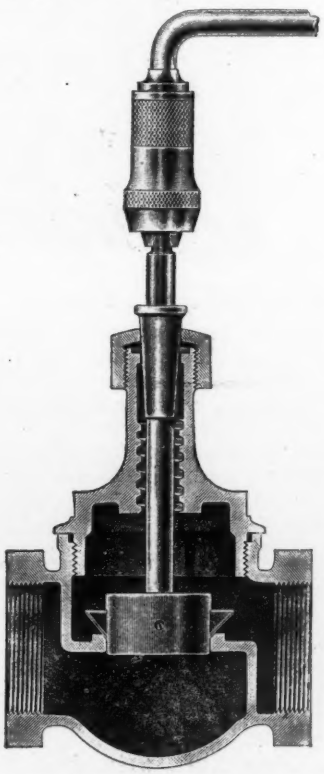


FIG. 1. SKINNER VALVE RESEATING TOOL IN OPERATING POSITION

PULLEYS SHOULD BE 25 per cent wider than the belts that they carry, perfectly round, smooth, with slight crowning absolutely central, and set to run true and in perfect alignment.

THE STICKLE STEAM TRAP

These are of 4 different types, the bucket, float, vacuum and the balanced, all made by the Open Coil Heater & Purifier Co. of Indianapolis, Ind. Two of them especially have novel features and will be described.

FIG. 2. THE PERFECT VALVE DISK

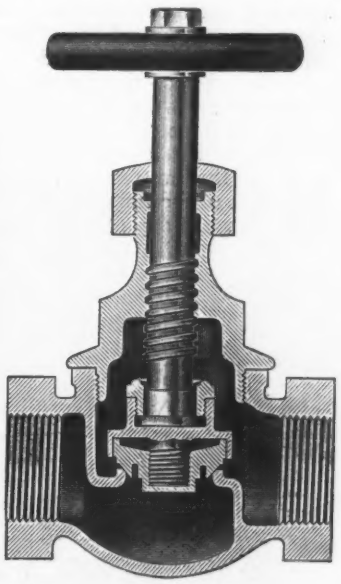


FIG. 3. SECTIONAL VIEW OF VALVE FITTED WITH A PERFECT VALVE DISK

The Stickle bucket trap, as shown in Fig. 1, has the inlet through an angular chamber, which extends clear around the trap, just under the flange. Four ports marked B lead from this angular chamber into the trap proper, as shown by the arrows. They are located at the top of the chamber and even with the top of the bucket so that the water which surrounds the bucket is maintained at the full height of the bucket,

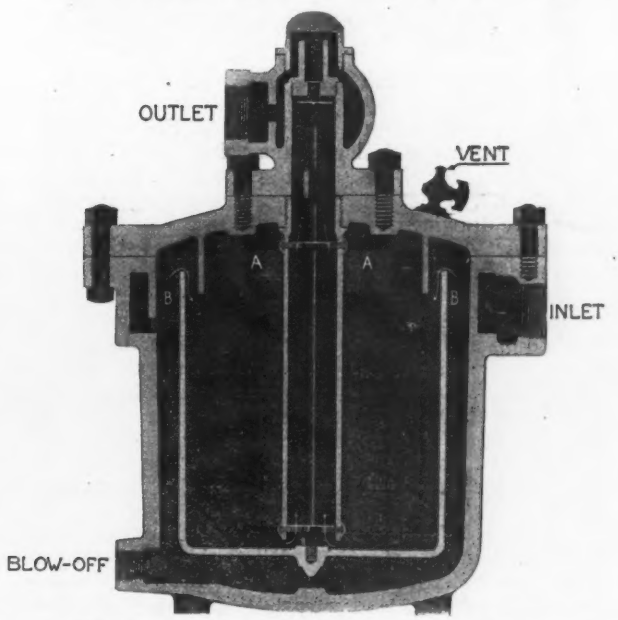


FIG. 1. STICKLE HIGH-PRESSURE BUCKET TRAP

and discharges into the trap when it is in operation directly across the top of the bucket. By this arrangement the water which floats the bucket cannot be blown out when the trap discharges.

Water and steam enter the trap in direct contact with the baffle or separating ring, which throws the water downward and the steam upward, steam entering the upper ports marked A, while the water flows over the edge of the bucket and fills it. When the bucket drops, water is forced out by steam pressure, through the central tube which extends down into the bucket and the lower end of which is sealed by the water in the bottom so that no steam can ever be blown out of the trap. An additional assurance against the discharge of any steam is that the column of water

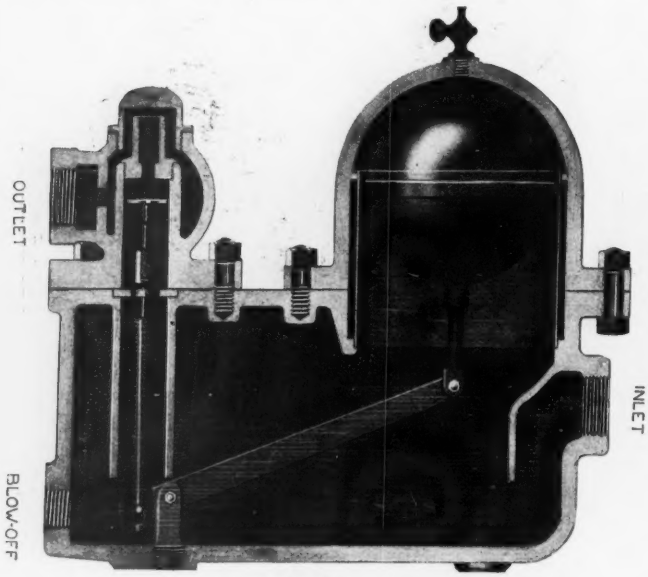


FIG. 2. STICKLE INTERMITTENT BALANCED FLOAT TRAP

flowing upward acts on the wings of the valve and tends to hasten the closing of the valve.

As the travel of the bucket is but ⅜ in. in opening and closing, it has quick operation, giving freedom from wire drawing and scoring of the valve. The discharged water flows up through the central tube, past the valve, over the top of the tube and then away from the outlet.

In the single intermittent balanced float trap, the method of discharge through a tube, valves and outlet is practically the same as in the bucket trap, but the opening of the discharge valve is accomplished by the raising of a float, contained in the float chamber, as shown in Fig. 2. By the use of a slot and a certain amount of lost motion, in the stem of the valve, the float is able to open and close the valve instantaneously, without causing vibration and without the valve being affected by any disturbance or waves of water in the water chamber. When the float does pull down on the valve stem, the valve drops the entire length of the slot, thus throwing wide open at once, and the valve stays open until the water is discharged from the trap, the float dropping gradually until it is low enough to close the valve, when the force of the stream of upward flowing water, acting on the wings of the valve, helps to throw it quickly shut. The inlet is into the back of the water chamber and the discharge is rapid so that all accumulated sediment is swept out of the trap at each discharge.

THE HYDRAULAGRAPH

In the important detail of pressing wheels on axles, there has never been discovered until now a successful method for making absolutely accurate diagrams of the ram movement in an hydraulic wheel press.

Such an instrument, however, has at last been produced, and after thorough experiments, has been pronounced a success. It is a product of the American Steam Gauge & Valve Mfg. Co. of Boston, and it is known as the Hydraulagraph.

The Hydraulagraph is built on principles following the general design of a continuous steam engine indicator, but adapted to hydraulic work. By this

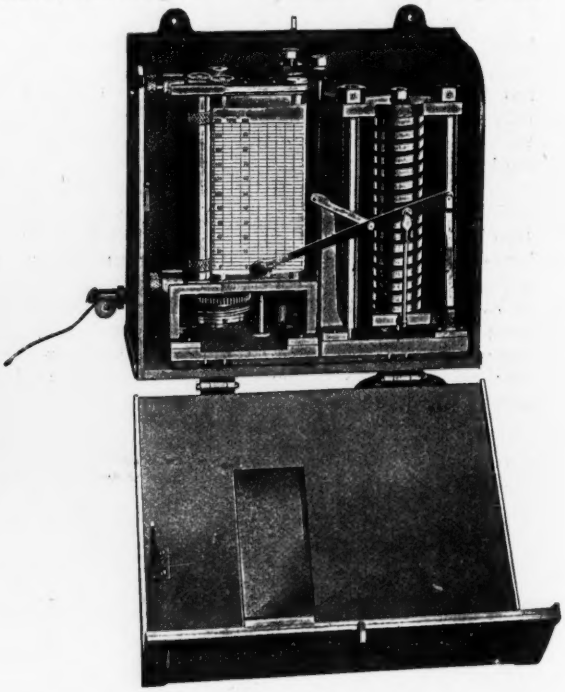


FIG. 1. THE HYDRAULAGRAPH WITH THE CASE OPENED

method a spring of great power of resistance and unerring accuracy is obtained, and, by means of an air chamber to take up the vibration which naturally must follow the tremendous pressure of the wheel press running up into 200 tons, a diagram is obtained with as clear a line as the diagram of the American-Thompson improved indicator card. The moment the operator at-

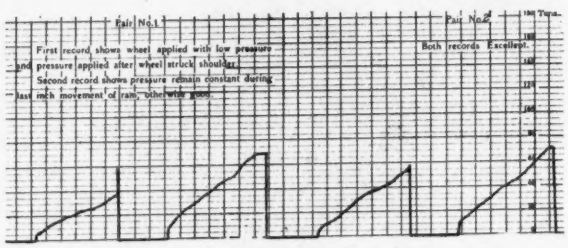

Pair No. 1
First record shows wheel applied with low pressure and pressure applied after wheel struck shoulder.
Second record shows pressure remain constant during last inch movement of ram, otherwise good.
Pair No. 2
Both records Excellent.

FIG. 2. CARDS TAKEN WITH HYDRAULAGRAPH

tempts to get the required maximum pressure on a loose fit, the diagram shows a vertical line. There is no way of disguising this, neither can the operator by any means obtain access to the diagram or pen. In fact, any effort on his part to hold the pen by means of such ingenious devices as he might make to reach down to it would only result in breaking the pen. The

only portion of the diagram accessible to the operator, therefore, is the marginal space left purposely for him to record wheel data, which is a necessary part of his work, and one of the most valuable records achieved in recent years toward the safeguarding of the public.

The chart is 100 ft. long; each quarter inch represents an inch movement on the ram, and the roll can easily record 400 complete movements, or 200 pairs of wheels. The diagrams which accompany this article were supplied by the American Steam Gauge & Valve Mfg. Co. The records were made in actual shop practice, and the comment which is made on the cards will explain in the briefest and clearest manner, the value of the Hydraulagraph and its diagrams.

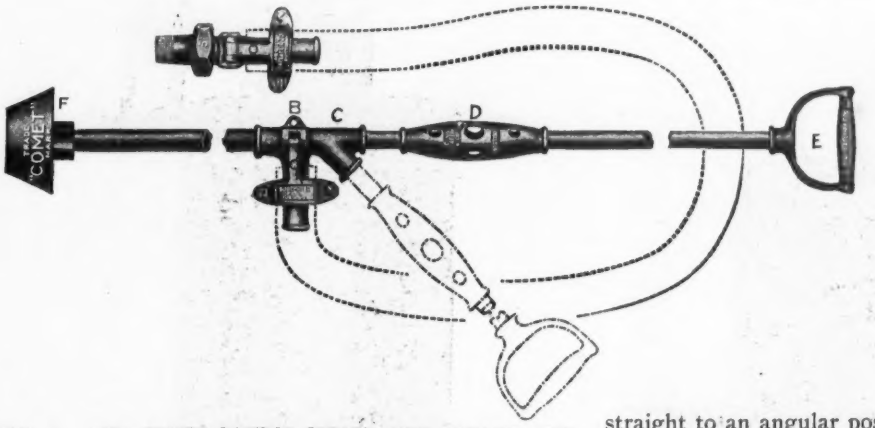


FIG. 1. THE COMET PATENT STEAM TUBE CLEANER FOR HORIZONTAL TUBULAR BOILERS.

A DEVELOPMENT IN STEAM TUBE CLEANERS

Chas. A. Claflin & Co., 58 High St., Boston, Mass., have perfected a tube cleaner known as the Comet that has many features of superiority, Fig. 1.

FIG. 2. THE HEAD OF THE COMET STEAM TUBE CLEANER.

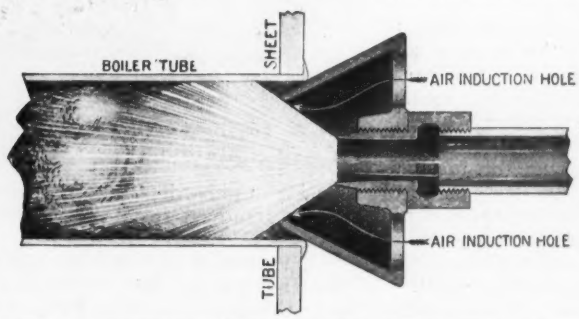


FIG. 3. SECTIONAL VIEW OF THE COMET HEAD IN OPERATION.

The head, Fig. 2, is comprised of but two parts; a frusto-conical hollow body with a single jet steam nozzle fastened into the center of its back end wall. In this wall is a series of air induction holes arranged to substantially surround the nozzle and forming a direct annular air passage open at both ends of the head. The nozzle is similar to those used in a steam injector, inasmuch as it is arranged to compel expansion in the direction of motion.

When the cleaner is in operation, a strong vacuum is created behind the nozzle by the rapid longitudinal expansion of the steam current. Air is thus induced in large volume through the air induction holes which not only relieves the vacuum by equalizing the atmospheric pressure at both ends, but it combines to augment the mass and accelerate the momentum of the current over 2¼ times throughout the tube, thus producing a most intense force, see Fig. 3.

The cleaner is made entirely of metal; the handle is tubular, therefore light and strong. As will be seen in the illustration, the handle is transposable from a straight to an angular position and an eye is provided for attaching a counterbalance, if desired.

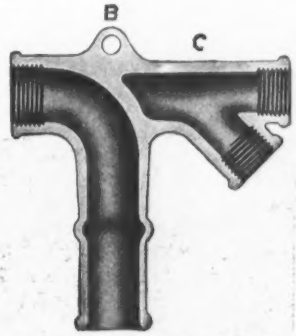


FIG. 5. SPECIAL HANDLE HOSE FITTING.

Each cleaner is equipped with the famous Sure-Hold hose fittings, the principle of which is well illustrated in Figs. 4 and 5 for rubber steam hose. A special fitting can be furnished when flexible metallic tubing is to be used.

The Comet tube cleaner is a portable outfit suitable for cleaning tubes of any number of boilers and being light it can be easily shifted from one boiler to another.

The manufacturers can furnish an independent automatic balanced valve constructed on the telescopic principle, making the cleaner self-closing. Vacuum tube cleaners are also manufactured by this company.

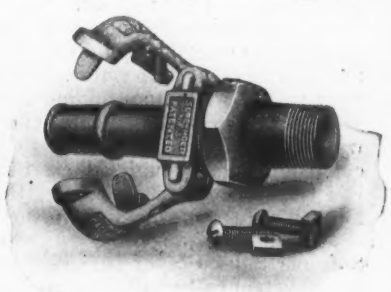


FIG. 4. SURE-HOLD PATENT HOSE FITTINGS.

Details of their full line are interestingly illustrated and described in a new catalogue that they will send upon request.

IT HAS BEEN FOUND that the ravages of woodpeckers on the telephone poles in the western country is largely prevented by treatment with creosote, or at any rate the creosoted poles have not been attacked by the birds, whereas untreated poles have been seriously injured. If this proves to be a universal remedy, the creosoting treatment will serve 2 purposes, protecting the poles from decay and also from destruction by birds and insects.

AN IMPORTANT WATER SOFTENING PLANT IN A GLASS WORKS

In the works of Ball Bros., glass manufacturers of Muncie, Ind., a great amount of trouble was experienced with boiler tubes and the glass blowing machinery on account of the bad water. It was necessary to take tubes out of the boilers each week for repairs and often new ones had to be put in. Incrustation in

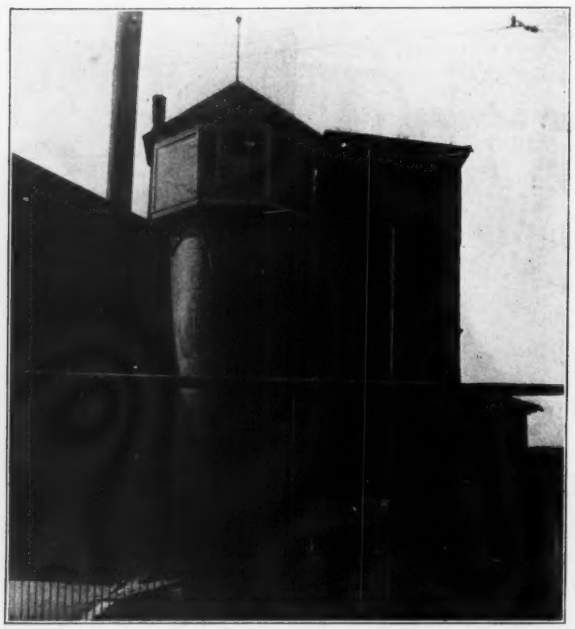


FIG. 1. NATIONAL WATER SOFTENER AT BALL BROS. GLASS WORKS

the glass blowing machinery also made a great deal of trouble and put the machinery out of commission sometimes for long periods.

It was evidently necessary to do something to remedy this wretched condition, as to the hardness and the alkalinity of the water. All kinds of treatment were tried, and without finding anything which seemed to take care of all difficulties with the water. Finally water softening was brought to the attention of the company, and through Albert Bingham, the mechanical engineer, a complete investigation was made of all water softening devices on the market, resulting in the placing of an order with the National Water Softener Sales Co., of Indianapolis, for a 5,000-gal. an hour system to be installed in the Ball Bros. plant.

As the Ball Bros. are the largest glass manufacturers in the world, it would be certain that their decision would be made only after a careful investigation, and thorough consideration of the best equipment for their needs. The deciding factor was that the National Water Softener has an absolutely automatic system of treating the raw water with no complicated machinery to get out of order.

The method of treating water is the same as that used by all other systems of softening, namely neutralizing the solids in solution by the use of certain chemical reagents. The superiority which decided this contract was in the simplicity of the measuring and mixing devices for both the raw water and the reagent. The softener has 5 parts and only 5: the solution tank which holds all the chemicals used to soften the water; the dumping bucket in which the raw water is accurately weighed, and measured, and which when the right amount of water is reached, automatically dumps it into the mixing chamber; the measuring valve which is operated by the motion of the dumping bucket, and which accurately measures the reagents into the mixing chamber in which the water and reagents are mingled; the precipitating tank

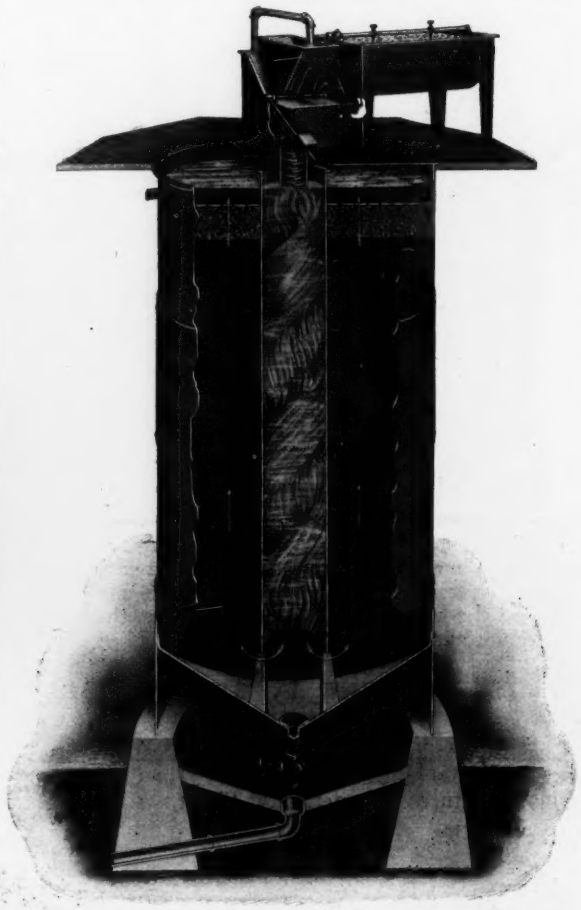


FIG. 2. SECTIONAL VIEW OF NATIONAL WATER SOFTENER SHOWING MECHANISM AND WORKING.

in which the hardening elements are finally and permanently removed from the water, leaving it pure and soft.

On account of the very perfect regulation of the National it is possible to get absolutely uniform results as to the quality of the water, and because of this very exact regulation, it is possible, in all cases, to bring down the alkalinity and causticity below the hardness. Figure 1 shows the view of the plant as installed at the Ball Bros. factory, and Fig. 2, a sectional view of the softener, showing the operating mechanism at the top, the central down-flow tube in which the mixing occurs, and the outer precipitating tank, through which the water slowly rises while the scale forming materials settle out into the bottom of the tank from which they are blown off.

The measuring apparatus consists of a bucket swung on a shaft with a weight counterbalance. Until full it is held in a horizontal position by the weight and when filled it tips to an inclined position, discharging into the mixing chamber. As it tips to discharge its con-

tents, it closes a trap door in the bottom of the mixing chamber, thus holding the bucketful of water in the mixing chamber while the measuring valve which takes reagent from the solution tank and discharges a measured amount of the reagent into the mixing chamber. This measuring valve is operated by the dumping bucket as it swings back and forth.

When the dumping bucket has emptied, the counterweight rights it to a horizontal position again and this motion closes the measuring valve from the solution tank and opens the trap door from the mixing chamber into the agitating tube leading to the precipitating tank. The water settles with a spiral motion through the inner tube of the precipitating tank and then rises around this tube and through a filter at the top.

Thorough mixing of raw water and reagents is insured, 1st by the stirring of the chemical solution in the solution tank by a stirrer operated by the dumping bucket; 2nd by the rushing back and forth of the raw water in the mixing chamber as it is poured from the dumping bucket; 3rd by a series of steps in the agitating tube; and 4th by the spiral motion in the downflow tube. The National softeners are made in any desired capacity for domestic, industrial or power plant uses, by the National Water Softener Sales Co., of Indianapolis, Ind.

THE PHILADELPHIA BOURSE FOR EXHIBIT AND SELLING

The writer of this article has for many years been familiar with the Exhibition Department of the Philadelphia Bourse; and has watched with interest the various kinds of machinery and appliances being shown and sold there. At no time has there been a better opportunity to open an office, and exhibit there, than at the present time.

The very best attention is given the exhibitors and buyers. All the machinery is cleaned each day, all telephone calls taken care of, and the janitors and the office of the Exhibition Department are always ready to answer any questions or inquiries, either pertaining to the department or as to where a certain class of goods can be obtained.

The results obtained by the concerns exhibiting in the Bourse have been very satisfactory, notwithstanding the hard times. Particularly is this true with the gas and gasoline engine concerns. There are many concerns represented in this line. Among the stationary line are the Otto, Alamo, Kenton, Mietz & Weiss and the Hornsby-Akroyd.

There are also steam engines, milling machinery of all kinds, tools of every description, bakers' machinery, boilers, food-water heaters and separators, and smaller articles in the mechanical line. There is no place better adapted as a selling medium than the Philadelphia bourse, as machinery of all kinds can be shown in operation.

The following concerns have recently placed exhibits and offices in the exhibition and selling department: L. J. Wing Mfg., Co., New York, fans and boiler room equipments; Brown & Sharpe Mfg. Co., tools; August Mietz, New York, gas and oil engines; De La Vergne Machine Co., New York, gas and oil engines, refrigerating and ice making machinery; Hires Engineering Co., Philadelphia, Pa., steam pumps; John G. Horton, Philadelphia, Pa., patent barrels and by-products; Trenton Engine Co., Trenton, N. J., steam and gas engines; American Diagraph Co., St. Louis, Mo., stencil cutting machines.

THE STRONG VACUUM TRAP

In all cases where steam engines are run condensing with any part of the exhaust piping or condenser above the cylinder of the engine there exists a constant danger of serious damage to the engine, due to water backing up into the cylinder. The apparatus most commonly used for draining the pipe is a vacuum trap placed at the lowest point in the exhaust main and discharging into the sewer or sump.

In the illustration, Fig. 1, is shown a sectional view of the Strong vacuum trap, which is extremely simple, reliable and durable and is manufactured by the Strong, Carlisle & Hammond Co., of Cleveland, O. In this view, the trap is shown discharging with the ball controlling the air inlet off its seat. Under these conditions, atmospheric pressure is established in the trap and the water in the trap will flow out by gravity through the swing check valve.

The valve rod operating the vacuum ball is shown to be in contact with the ball and the atmospheric pressure in the trap is transmitted through the valve port into the trap covering the vacuum ball, thus holding this valve to its seat, by a pressure equal to the difference in pressure between the atmosphere and that carried in the vacuum main. In the conditions

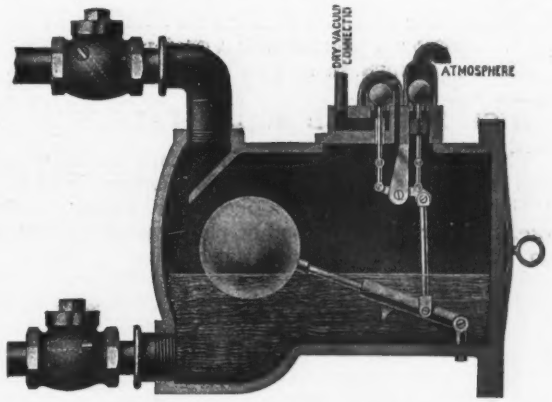


FIG. 1. SECTIONAL VIEW OF STRONG VACUUM TRAP

shown, water is flowing out of the trap and the tendency is for the ball float to drop with the water line, but it cannot do so because the vacuum rod is in contact with the vacuum ball, and cannot lift it as it is held to its seat by the pressure above mentioned.

The water, therefore, continues to flow out of the trap, dropping away from the ball float, until the weight of the float becomes sufficient to lift the vacuum ball. When this occurs, the float drops to the new water line, and the vacuum ball is lifted off its seat about 0.5 in. and the rod operating the atmospheric ball drops the same distance, permitting the atmospheric ball to drop to its seat.

The trap is then closed to atmosphere and opened to the vacuum through the dry vacuum pipe. In 3 or 4 seconds the same vacuum will be established in the trap as is maintained in the system being drained. The condensed water will then drop by gravity from the system into the trap. The rising of the ball float will open the atmospheric valve and close the vacuum valve, just the reverse of the operation explained above.

The method that should be followed in connecting up the trap to condensing engines is shown in Fig. 2. The location of the trap, may of course, be changed to meet conditions and should always be placed below

the vacuum line and the dry vacuum connections made at a point where it will be free from moisture. The check valves should be of the swing type, and installed in a horizontal position as illustrated.

In Fig. 3 is shown the method of connecting the trap to a dry vacuum oil separator, for the purpose of draining off the entrained oil and condensation.

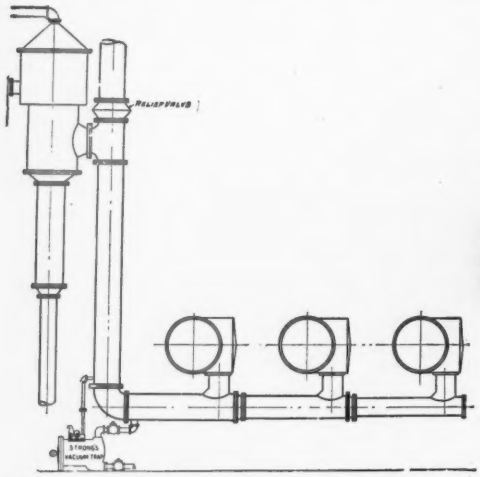


FIG. 2. METHOD OF CONNECTING A TRAP IN A CONDENSER SYSTEM

HIGH DUTY AND BOILER FEED PUMP

The cuts illustrate the boiler feed pump manufactured by The National Steam Pump Co., Upper Sandusky, O., having an improved inside valve motion. The water cylinder is of the hood or plate type, giving quick and complete access to the water valves. The suction and discharge openings are located on opposite sides and below the valve plate, rendering it unnecessary to de-

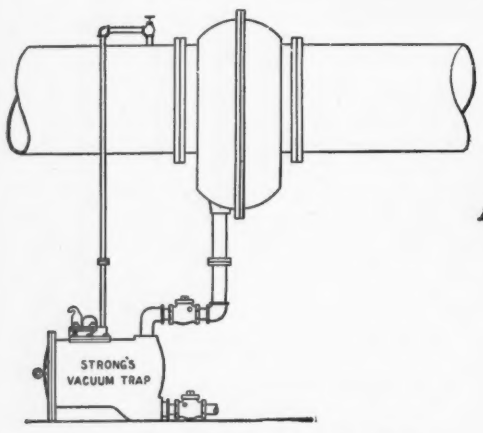
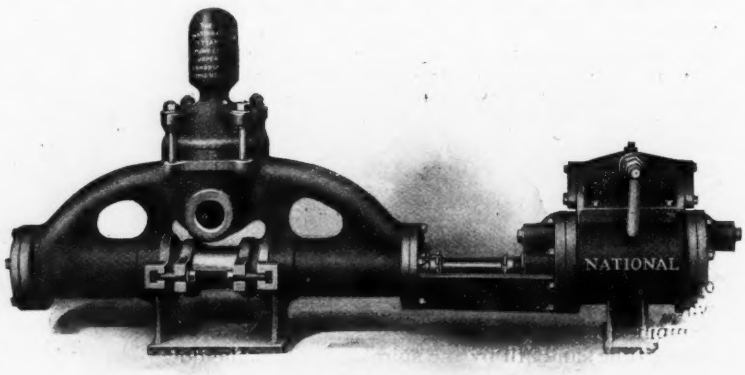


FIG. 3. TRAP CONNECTED TO VACUUM OIL SEPARATOR

range piping when making repairs. The cylinder is reversible so that pipe connections may be changed to suit local conditions.

The pump is regularly fitted with Tobin bronze piston rods, special hard iron plunger, brass valve seats, bolts, springs and guards, and hard rubber valves, unless otherwise specified.

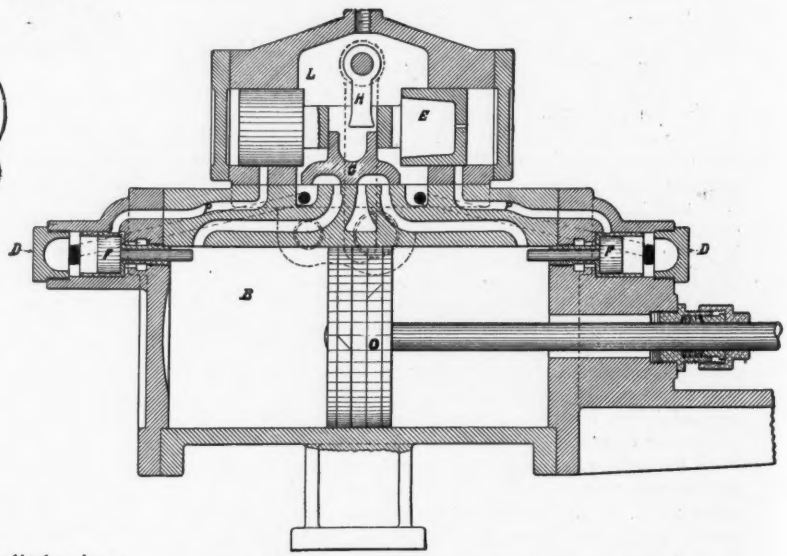
The piston, O, is driven by steam under the valve, G, which, as it is shifted backward and forward alternately, connects opposite ends of the cylinder, B, with the live steam pipe and exhaust. This valve, G, is shifted by the auxiliary plunger, E. This plunger is hollow at the ends, which are filled with steam, and this issuing through a hole in each end fills the spaces between it and the heads



THE NATIONAL HIGH-DUTY PUMP

of the steam chest in which it works. Pressure being equal at each end, this plunger, E, under ordinary conditions is balanced and motionless, but when the main piston, O, has traveled far enough to strike and open the reverse valve, F, the steam exhausts through the port, P, from behind that end of the plunger, F, which immediately shifts accordingly and carries with it the slide valve, G, thus reversing the pump.

No matter how fast the piston may be traveling it must instantly reverse on touching the valve F. In its movement the plunger, E, acts as a slide valve to close the port P, and is cushioned on the confined steam between



SECTION OF NATIONAL PUMP STEAM END

the port and steam chest head. The reverse valves, F F. are closed as soon as the piston, O, leaves them, by a constant pressure of steam behind them, conveyed direct from the steam chest through the ports shown by dotted lines.

CATALOG NOTES

A NEW METHOD for calculating drying equipments is described in "Drying in Industrial Plants," a brief treatise just published by The Green Fuel Economizer Co. The first part of the book discusses the elementary theory of drying and then describes drying equipments as used in various industries. The latter part of the book contains a chapter on drying engineering and gives an original method for calculating the amount of air and steam required for drying a given material under prescribed conditions. The book should be of interest, not only to manufacturers who have drying work to do, but also to engineers who design and construct plants of this character. The booklet will be supplied gratis on request, by The Green Fuel Economizer Co., Matteawan, N. Y.

FROM THE MANISTEE IRON WORKS CO., Manistee, Mich., comes a bulletin describing a new duplex pump with valveless steam end, warranted to start from any position, not to short stroke or jam the heads. It is furnished in piston pattern for low pressures and in outside packed plunger or piston patterns for high pressure.

PEERLESS PORTABLE ELECTRIC DRILLS, REAMERS AND GRINDERS are fully described in a catalog just issued from S. Obermayer Co.

FROM THE WETZEL MECHANICAL STOKER CO., of Trenton, N. J., comes a beautiful new edition of the catalog describing the Wetzel automatic stoker. This shows the arrangement of the stoker, its application to different types of boilers, the appearance of the stoker under construction and as it is operated in various plants, and gives a full description of the details. It has a fine loose-leaf cover, with handsome red and black design and is printed in black with decoration of red on all pages.

THE TRIUMPH STEAM ENGINE INDICATORS AND APPLIANCES as made by the Trill Indicator Co., of Corry, Pa., are the text for an interesting description given in the latest catalog just issued. There are too many details to be mentioned in a brief notice, but these and the information contained in regard to the use of the indicator and the study of indicator cards are well worth the attention of every engineer, and can be had by writing to the company for a copy of the catalog.

FAIRBANKS, MORSE & CO., of Chicago, has just issued a new catalogue of wood and steel windmills, giving the theory and details of construction. Pumping systems are described in detail. The technical information and practical suggestions contained in this book are worth while having.

SOLID WEDGE VERSUS DOUBLE DISCS is the title of an interesting pamphlet issued by the Nelson Valve Co., of Philadelphia, Pa. It shows the action of the single solid tapered wedge seat, and the result when the seats on the solid wedge valve are distorted, and the special reason for the double disc design. It's a pamphlet worth reading.

THE SAWYER BELTING BOOSTER for October shows the use of Sawyer belts in cement plants, and gives an interesting testimonial from the Diamond Portland Cement Co., showing what they think of Sawyer belting after a long trial under the most severe conditions.

FAIRBANKS, MORSE & CO., of Chicago, has issued a new catalog which describes in detail the principles of operation and construction of its gasoline engines, and has many engineering suggestions stated in plain language for the benefit of those who are not familiar with gas engine practice.

THE GENERAL ELECTRIC CO. has issued bulletins as follows, which will interest readers:

Bulletin No. 4665, entitled "Electrical Operation of Pulp and Paper Mills," illustrates and describes the application of the electric motor to the paper industry.

Bulletin No. 4688 describes a new meter board made of molded material which is intended to replace the customary wooden board used in mounting meters. The board is provided with a supporting screw at the top, and 2 adjustable clamps at the bottom, which permit of quick leveling and securing of the meter.

Bulletin No. 4680 gives the comparative cost of sign lighting with carbon and tungsten lamps, which is shown by means of curves. This bulletin will be of interest alike to the central station man and the customer.

Bulletin No. 4699 is devoted to a description of the company's new type of motor-driven air compressors and will be of interest to all who have use for compressed air either in connection with railway or stationary work.

Bulletin No. 4700 describes the company's Type R-2 voltmeters and ammeters for use on alternating and direct-current switchboards. A prominent feature of this instrument is the large window opening, wide pointers, and legibility of scales. This publication contains dimensions of the instruments and reproductions in actual size of the various scales.

The extensive adoption of fireproof devices in cotton mills, flour mills, saw mills and other establishments operating under similar conditions has made necessary a compact, fire and dust-proof, oil break switch of small capacity and moderate cost. A switch of this character is described in Bulletin No. 4682.

Bulletin No. 4691 describes motors for use in connection with small machines found in machine shops, both single-phase and polyphase motors of a type which can be arranged for use not only in a horizontal, but in a vertical position. These motors can be furnished totally inclosed, and when so made are specially constructed with a view to increased radiating surface.

FROM THE HOHMANN & MAURER MFG. CO., of Rochester, comes a pamphlet addressed to "those who think they do not need thermometers," explaining what may be accomplished in a power plant by a good installation and systematic keeping of records.

STEAM SPECIALTIES for power plants and steam heating handled by W. D. Allen Mfg. Co., of Chicago, are fully described and illustrated in Catalog 20 issued by that company.

THE TRILL INDICATOR CO., of Corry, Pa., has just issued an attractive 44-page booklet describing its various types of indicators. This book also describes the Faultless reducing motion, Trill planimeter, and indicators for high-pressure and ammonia work. Besides the description of the apparatus, interesting discussions are given on numerous cards and the causes of various unusual curves pointed out. A method is also given for drawing adiabatic and saturation curves. There is also a chapter on indicating gas engines with discussions of faulty diagrams and a chapter on indicating compound engines and drawing combined cards.

IT CERTAINLY IS A BEAUTY that catalog that the Dearborn Drug & Chemical Works are putting out, telling about water treatment. It has an embossed cover in artistic design, printed in 3 colors, and the inside pages are filled with lithograph and half-tone decorations that add greatly to the attractiveness of the book. The methods of treating and the facilities of the Dearborn Drug & Chemical Works for handling such treatment are shown by photographs of the works and offices, of the laboratories and analysis rooms, and the apparatus used

in testing. These tests are for boiler waters, fuels and lubricants, and show the extreme care exercised in getting at the facts in order to recommend proper treatment for each individual case. The results of bad water are shown and the method of making up the special prescriptions for the treatment of bad water, also the methods of proportioning and mixing oils for lubricating different parts of machinery which run under varying speeds and loads. The company may well be proud of the book which it has issued and any engineer will be interested and benefited by reading through its pages. A copy can be had by application to the company's main office in the Postal Telegraph Building, Chicago.

THE B. F. STURTEVANT CO., of Hyde Park, Mass., has ready for distribution its new general catalog No. 165, entitled "What We Make." It is a condensed summary of the company's products, showing the complete line of fans, blowers, dust collecting and conveying systems, fuel economizers, engines, heaters, turbines, etc. It is full of valuable data, including principal dimensions of apparatus, surfaces required for heaters and economizers, sizes and capacities of blowers and fans, capacity of generating units and other information. Those interested in such machinery will be supplied with copies of this catalogue on request.

THE BULLETIN NO. 115, of the American District Steam Co., discusses "The Financial Effect of Combining an Exhaust Steam Heating System with an Electric Light and Power Plant." It gives a brief history of the use of exhaust steam for heating, particularly from central stations, and then takes up the relative economy of heating and of running condensing, and shows the profit which may be derived by selling exhaust steam for house and building heating. It shows also the details of constructing a satisfactory system for the distribution of exhaust steam from a central station, including piping, expansion joints, condensation meters, water heater and connections, and connections from the district system to a house heating system.

A LITTLE TWELVE-PAGE BOOKLET of envelope size has just been issued by the Joseph Dixon Crucible Co., describing facings for various kinds of work. The purchasing agent will be glad to know that the listings include prices. Some general information in brief on the proper use of facings, values of different kinds, working conditions met in foundry practice, and so forth, is given in the booklet. Just address the Joseph Dixon Crucible Co., Jersey City, N. J., who will send you this interesting booklet free of charge.

THE RELIANCE OIL & GREASE CO., of Cleveland, O., is distributing a neat little 12-page booklet describing the various good qualities of its animal, vegetable and mineral oils. These lubricants are made to be used on all classes of machinery, and the booklet which may be had for the asking gives information hard to find elsewhere.

TRADE NOTES

ALLIS-CHALMERS CO. has recently received orders for steam turbines aggregating a total of 25,225 kw. These figures are only a fair indication of the demand for the improved type of horizontal steam turbine. The large number of repeat orders received by the company testify to the economical and reliable operation of the units in service. Recent contracts for new machines comprise turbines ranging from 300 to 3,000 kw. for generating current in a great variety of industries. Among the purchasers of large units are the Nashawena Mills, New Bedford, Mass., where 2 3,000-kw. units as well as 1 of 500-kw will be installed; the Whitman Mills, New Bedford, Mass., 2,000-kw.; the Wilmington City Electric Co., Wilmington, Del., 1,500-kw., and the Paine Lumber Co., Oshkosh, Wis., who have contracted for 1,000 and 500-kw. turbines. The Diamond Rubber Co., of Akron, Ohio, manufacturers of rubber wearing apparel, auto tires and rubber novelties, has purchased a 1,250-kw. low-pressure turbine. Many sales of smaller sizes have been made.

GREENE, TWEED & CO., of New York City, has brought out a new specialty for engineers and machinists in the shape of the Colvin Interchangeable Rawhide Hammer. This has a metal head and rawhide faces which may be renewed, and thus gives a striking surface which will not mar finished surfaces or tools, is resilient and yet hard enough to give a heavy blow when required. The rawhide ends are held in place by a split clamping device made into the metal of the head.

NEW INSTALLATIONS RECENTLY COMPLETED by the Wetzel Mechanical Stoker Co., of Trenton, N. J., are found in the works of the J. L. Mott Co., Trenton, N. J., the People's Brewing Co., Trenton, N. J., Princeton Worsted Mills, Trenton, Trenton Street Railway Co., and John A. Roebling's Sons Co., of the same city, the American Ice Co., of Philadelphia, and the plant of the same company in New York. Contract has recently been secured for 10,000 hp. of Wetzel stokers to be installed in the new plant of the Metropolitan Electric Co., of Reading, Pa., which, when completed, will be one of the finest electric plants of its size in the country. The boilers installed in this plant are made by the Edge Moor Iron Co., Edge Moor, Del., and the electrical machinery by Allis-Chalmers Co., Milwaukee, Wis.

THE TRANSMISSION DYNAMOMETER, invented and patented by Prof. W. H. Kenerson and illustrated and described by him in a paper read before the meeting of the American Society of Mechanical Engineers at Washington in May, 1909, is a device which indicates by means of a pressure gauge, the amount of power transmitted through it. The dial on the gauge is graduated to show the horsepower per hundred revolutions per minute of the shaft to which the dynamometer is attached.

It is sensitive and correct to a degree very closely approximating that of the ordinary gauge for indicating pressure and the construction is such that it cannot easily be deranged.

This transmission dynamometer is being built and placed on the market by the Builders' Iron Foundry, Providence, R. I.

A. M. MORSE, CHICAGO, district manager for Harrisburg Foundry & Machine Works, reports among recent sales of Fleming-Harrisburg engines for direct connected electric generating sets the following: Thomas B. Jeffery & Co., builders of Rambler automobiles, Kenosha, Wis.; Indiana Springs Co., "Mudlavia," Kramer, Ind.; Northern Indiana State Soldiers' Home, LaFayette, Ind.; C. H. Campbell Furniture Co., Shelbyville, Ind.; G. Heileman Brewing Co., LaCrosse,

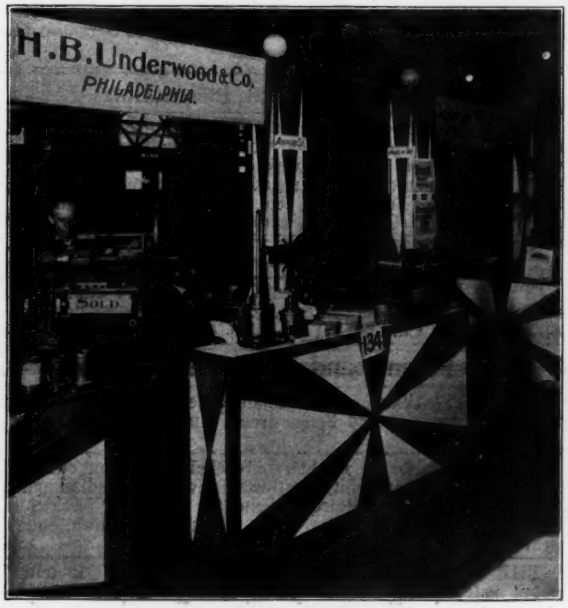
Wis.; L. S. & M. S. R. R. Co., Toledo, O.; Lehigh Valley R. R. Co., Bound Brook, N. J.; Delaware, Lackawanna & Western R. R. Co., Buffalo, N. Y. The engine for Thomas B. Jeffery & Co., is of the Harrisburg improved Corliss-valve non-releasing gear type, and will drive a 360-kw. alternator at 150 r. p. m., and having the exciter as well as the alternator directly connected to the engine shaft.

THE NORTHERN WATER SOFTENER CO. of Madison, Wis., reports the closing of a number of large contracts during the month of August for the installation of their water softening system. Some of the important ones include the Cedar Rapids & Iowa City Railway & Light Co., Cedar Rapids, Iowa, a 20,000 gal. per hour machine; Power Construction Co., Galena, Ill., for a 15,000 gal. per hour machine; Sandusky Portland Cement Co., Sandusky, Ohio, a 10,000 gal. per hour machine; Webster City Electric Light & Water Works, Webster City, Iowa, a 2,000 gal. per hour machine; Los Angeles Paper Manufacturing Co., Los Angeles, Cal., a 2,000 gal. per hour machine; Ada Water, Heat & Light Co., Ada, Ohio, a 1,500 gal. per hour machine. Some interesting literature, illustrating the Bartlett systems of water purification will be mailed to anyone interested.

AS AN EVIDENCE of the class and grade of work done there, the estimate of the Yale and Towne Works at Stamford, Conn., shown by a summer incident is interesting. A student of Sibley College, Cornell University, inquiring as to how much credit he would obtain for shop work done during the vacation, was told that it was the practice to give 1 hr. credit for every 2 hr. devoted to actual work in a shop or foundry, provided the latter were approved by the faculty as a proper place for gaining useful experience. Asking if the Yale & Towne Works at Stamford would fit this description, he was informed that double credit would be given for any time spent in these works, as, in the opinion of the faculty, it was the full equivalent of the instruction given at the college, and that in this respect it ranked with a very few of the leading industries of the United States.

AT THE RECENT CONVENTION of the Cotton Oil Manufacturers, The Plomo Specialty Mfg. Co. of Cleveland, O., distributed handsome mailing cards showing the artistic setting that cotton bolls can make for the smiling face divine of the girl of your heart.

THE NIXON-LANCASTER ENGINEERING CO., of Denver, Colo., has been doing some interesting installation work recently. One of the jobs is the installation of a plant in the Jacobson Hotel, Denver, where they are installing boilers and steam heating plant, mechanical refrigeration and full mechanical equipment. They are also installing in Sterling, Colo., a 30-ton refrigerating plant with ice storage, including a York compressor and all the latest improved apparatus from the York Company. All rooms throughout this plant are insulated with cork.



THESE PHOTOGRAPHS OF BOOTHS AT COLUMBUS CONVENTION ARRIVED TOO LATE FOR PUBLICATION IN OCTOBER ISSUE

THE GIBBES MACHINERY CO., Columbia, S. C., has recently sold Murray Corliss engines to be installed for the town of Wilson, N. C., the Cotton Oil Co., at Bamberg, S. C., and the Southern States Oil Refining Co., at Zebulon, N. C. These are their very latest sales and indicate good activity in that field and of that company.

THE CURTIS & CURTIS CO. of Bridgeport, Conn., manufacturers of the Forbes Patent die stock reports a decided improvement in business, and is running its plant at full capacity in all departments. This company reports recent sales of 2 of the largest machines of its manufacture, range from 4 to 15 in., to the Davis Coal & Coke Co., Thomas, W. Va., and Atlantic City Electric Co., Atlantic City, N. J., also large orders for export.

THE JACOBSON ENGINE CO. recently received the following letter from a customer which speaks well for the producer gas apparatus of its make:

You will be interested to hear of the year's work of the 85 hp. Jacobson producer gas engine installed in my flour mill. I started this engine a year ago yesterday, and have consequently made a full year's work. During that time we have lost very little time, having

run steadily 11 hr. per day, and 6 days in each week, with few exceptions. We have ground more grain than we used to grind in a year with a good automatic engine capable of delivering over 110 indicated hp.; the attendance has been much less troublesome, and the fuel bill has been less than one-fourth of what it averaged for the same length of time when running with steam. The fire has been out only once in the producer during the year, and that was in the first month's work. Consequently we have not had the fire out or cleaned the producer or done any work to it except the regular daily routine of coaling up and cleaning fires, up to this date. We do this only once each day, and the labor, when compared with keeping a boiler in condition and firing it, is practically nothing. Our repair bill on the engine has been small, required for only a few extra springs, and new igniter points. The power is an especially steady one, and we have developed over 100 hp. for hours at a stretch without difficulty. It is not out of the way to say that we use but little more coal in a week than we formerly used in a day for the same amount of work from a steam plant.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rate of 40 cents per line. About nine words make a line. No display type is allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office on or before the 15th of month preceding publication.

Positions Wanted

POSITION WANTED—By a man, 26 years old, with 3 years' experience with machinery. Good references as to honesty, sobriety and ability. Harry Kelley, R. R. 39, Prattville, Mich. 11-2

POSITION WANTED—By strictly sober man as steam or gas engineer. Hold same position now, but have reasons for change. Good references and hold Ohio state license. Address Box 117, Practical Engineer. 10-2

POSITION—Young man, 21 years old, wants position as assistant engineer or helper. About half through with an I. C. S. course in Mechanical Engineering. Also a Band man. Strictly temperance. For further information address Henry Herbert Carter, Box 271, Vulcan, Mich. 11-2

POSITION—Young man, 20 years old, wants position as fireman's helper. All around man in place with a chance to make good and learn business. Few months' experience in small office building plant. Strictly sober, attentive and willing to learn. Dominick Cavalla, 245 Pacific St., Brooklyn, N. Y. 10-2

POSITION WANTED—By engineer, 26 years old, 8 years' experience with high speed automatic and Corliss engines, A. C. and D. C. generators, air compressors, water and fire tube boilers, stokers. Hold first class license for Ohio. Own indicator and tools; married; use no liquor or tobacco. I. C. S. man. Will take charge of any plant up to 2,500 H. P., middle west or west. Will be free Dec. 1. State salary. Address Box 118, Practical Engineer. 10-2

Help Wanted

NICE SIDE LINE for steam specialty salesmen. Reiter Boiler Cleaner Co., Elgin, Ill. 9-tf

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 13 of this issue. 9-tf

ENGINEERS AND MECHANICS—To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. 4-tf

For Sale

FOR SALE—All kinds of high grade rebuilt engines, boilers, etc. See list in display advertisement in another part of this issue. The Randle Machinery Co., 1767 Powers St., Cincinnati, O. 10-tf

FOR SALE CHEAP—Six 66" x 18' second hand tubular boiler shells with 66 4" tubes, good for 125 pounds steam pressure. Also four 42" steel stacks 90' long and one 72" stack 90' long, heavy plate. Address Box 119, Practical Engineer. 11-1

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Machinery For Sale.

FOR SALE—ENGINES AND BOILERS—Corliss—Heavy Duty, 18 x 36 Ohio, 24 x 30 Clark, 22 x 48 Allis. Girder Frame. 14 x 30 Bass, 18 x 42 Allis, 22 x 42 Hamilton, 28 x 54 Hamilton. Automatic—All sizes, 30 to 400 hp. Send for list. Throttling engines from 10 to 100 hp. Woodworking machinery of all kinds. Cleveland Belting & Machinery Co., 1922 Scranton road, Cleveland, Ohio. 9-tf

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Books

"THE BOILER," by Stephen Christie. Every engineer will profit by a study of its contents. 6 x 9, 264 pages. Cloth bound, $1.00. Stephen Christie, 171 La Salle street, Chicago. 10-2

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PATENTS—Watson E. Coleman, Patent Attorney, Washington, D. C. Advice and books free. Highest references. Best services. 4-tf

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ENGINEERS—Pack your Corliss valve rods with Ideal Metallic Packing. Three years' guarantee. Price per inch diameter of rod $1.00. Ideal Metallic Packing Co., South Stillwater, Minn. 8-tf

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FREE, ANY FIRM owning a steam plant, or any engineer in charge of steam plant, that is troubled with scale and has to use boiler compound can get the best indicator and reducing wheel made, free. Address Great Lakes Chemical Co., Manitowoc, Wis. 10-tf

ORANGES, GRAPEFRUIT, TANGERINES as Christmas presents for your friends. Either mixed boxes, or one kind in box shipped to any address on receipt of price, cash with orders. All orders must be in 2 weeks before Christmas. Nothing less than box shipped. Oranges, per box, $1.65; grapefruit, per box. $3.00; mixed fruit, per box, $1.75; tangerines, per strap, $2.00. All fruit picked same day shipped and guaranteed to be first class. Address M. M. Shellaberger, R. No. 1, Bartow, Fla. 11-2